

UPDATE to the Wood et al. 2001 TERRESTRIAL STUDIES REPORT

18 February 2002

Introduction

The following document summarizes data collected in 2001 and additional analyses of the data collected in 1999-2000 that were not included in the original report. Note that additional analyses for the raptor data are not included here because a master's thesis (Balcerzak 2001) has already been submitted with these data. The sections included in this update are as follows:

A. Species-Specific Logistic Regression Models

Regression models were developed for grassland and edge species as requested in the review of the original report. Reclaimed mines are providing habitat for these species, although we do not know if populations are breeding successfully. Regression models for grassland species generally indicate that dense vegetation is not suitable habitat, therefore, reclaimed grasslands will not remain suitable for these species without active management. Models were developed for additional interior-edge and forest-interior species. For all analyses, we used stepwise logistic regression.

B. Grasshopper Sparrow Habitat and Nesting Success

Additional data collected in 2001 confirm that reclaimed grassland habitats provide suitable breeding habitat for Grasshopper Sparrows as long as vegetation does not become too dense.

C. Small Mammal Sherman Trapping Data

Additional analyses of the 1999 and 2000 small mammal data suggest higher productivity for *Peromyscus* species within the reclaimed grassland habitats. Abundance was negatively related to bareground.

D. Small Mammal Data from Herp Arrays

Additional species were captured in pitfall traps associated with arrays (particularly shrews) resulting in greater species richness within the reclaimed habitats. For woodland jumping mice and short-tailed shrews, abundance was greater in fragmented forests, similar to findings from the sherman trap data.

E. Herpetofaunal Surveys

The two years of data had trends similar to those reported in the original report for the 1-year data set. Overall species richness and abundance based on the array data for 2000 and 2001 did not differ among treatments. Although salamander abundance did not differ statistically among the treatments, it was generally higher within the 2 forested treatments.

F. Appendix A-1. Changes to the Wood et al. 2001 MTMVF terrestrial report

Logistic regression models were updated and none of the species tested showed negative relationships with distance to edges. In logistic regression analyses, we used stepwise selection rather than the forward selection used in the original report. See methods of section A in this report for a description of why we switched analyses to stepwise selection.

A. Species-Specific Logistic Regression Models

In the final report we included species-specific logistic regression models for several forest-interior species listed as species of concern by Partners in Flight (PIF). Here we provide habitat models for 32 additional species: 6 grassland, 13 edge species, and 13 forest species.

In response to review comments from the W. Va. Coal Association, we are adding more information on grassland and early successional species that were detected on MTMVF mines. Many of these species are declining in all or part of their breeding range (Sauer et al. 2001), and MTMVF mines may provide habitat for these species in a region that is dominated by mature forest habitat. Generally, the breeding range for grassland and early successional species is extensive throughout the United States. Historically, little of the breeding range for grassland species occurred in West Virginia; consequently, these species generally were uncommon. We present findings on 6 grassland species: Dickcissel, Grasshopper Sparrow, Eastern Meadowlark, Red-winged Blackbird, Horned Lark, and Willow Flycatcher, and 13 edge species: White-eyed Vireo, Yellow-breasted Chat, Prairie Warbler, Blue-winged Warbler, Common Yellowthroat, Yellow Warbler, Indigo Bunting, Northern Cardinal, American Goldfinch, Song Sparrow, Chipping Sparrow, Field Sparrow, and Eastern Towhee.

Of the grassland species, the Dickcissel was found to be declining significantly range-wide from 1966-2000 by the Breeding Bird Survey (BBS), but the species was not detected on any routes in West Virginia (Sauer et al. 2001). All of the other species, except the Willow Flycatcher, were found to be declining in West Virginia and range-wide. Willow Flycatcher populations appear to be stable both in West Virginia and range-wide. Of the edge species, the BBS found the Prairie Warbler, Common Yellowthroat, Indigo Bunting, American Goldfinch, and Eastern Towhee to be declining significantly in West Virginia and range-wide. White-eyed Vireo, Yellow Warbler, Blue-winged Warbler, and Northern Cardinal populations appear to be stable both in West Virginia and range-wide. The Yellow-breasted Chat and Chipping Sparrow appear to be declining in West Virginia, whereas populations are stable range-wide (Sauer et al. 2001). The Song Sparrow is declining range-wide, but populations appear stable in West Virginia.

Additional models for 13 forest species also are included in this report. Of the 13 species analyzed, 8 are interior-edge species and 5 are forest-interior species. The interior-edge species analyzed were: American Redstart, Carolina Chickadee, Northern Parula, Carolina Wren, Downy Woodpecker, Tufted Titmouse, Red-bellied Woodpecker, and White-breasted Nuthatch. The forest-interior species were: Black-throated Green Warbler, Ovenbird, Pileated Woodpecker, Yellow-throated Warbler, and Summer Tanager. Of these species, 6 are considered “residents” (i.e. they do not migrate for the winter): Carolina Chickadee, Carolina Wren, Downy Woodpecker, Pileated Woodpecker, Red-bellied Woodpecker, Tufted Titmouse, and White-breasted Nuthatch.

Methods

We modeled habitat preferences of these additional species using stepwise logistic regression (Stokes et al. 1995). We chose to use stepwise logistic regression over forward logistic regression for two reasons. First, forward selection is a simplified version of stepwise regression; it does not test whether a variable once entered into the model should be dropped as other variables are added (Neter et al. 1996). Thus, the final model in forward regression may include variables that would have been dropped as new ones were added in stepwise regression. We found with our data that forward regression typically chose more variables for

inclusion in the model than stepwise regression. Because stepwise both adds and deletes variables as it proceeds, we believe it produces the "best" regression model. Second, stepwise regression is the most widely used procedure (Neter et al. 1996) and is typically the method used by other ornithologists and wildlife biologists. The significance level for entry and staying in the model was $P=0.10$. The Hosmer-Lemeshow goodness-of-fit test was used to determine the validity of the models. Models that failed the goodness-of-fit test ($P<0.10$) were considered invalid (Stokes et al. 1995).

For grassland and edge species, analyses included only points in the grassland and shrub/pole treatments. We developed models for species detected at $\geq 10\%$ of these sampling points. Both treatments were included in the development of the models because some grassland birds were detected in shrub/pole habitat and some edge birds were detected in grassland habitat. Habitat variables included in models for grassland species were: aspect code, slope, distance to minor edge, distance to habitat edge, height of grass/forbs, litter depth, Robel pole index, elevation, density of trees $>0-2.5$ cm, $>2.5-8$ cm, and $>8-23$ cm, and all ground cover variables. These variables also were used in models for edge species, along with density of trees $>23-38$ cm, and density of snags. Density of larger trees were excluded from models because no trees >38 cm were found in these habitats, and no snags were found in the grassland habitat.

For the 13 additional forest species (interior-edge and forest-interior species), we used the same methods and variables as we used for the species in the final report and as described above for the grassland and edge species.

Results and Discussion

Grassland Species and Edge Species

Grassland Species

Dickcissel

We found Dickcissel presence to be positively correlated to distance from habitat edge, Robel pole index, and bareground/rock cover (Table 1). This indicates that Dickcissels prefer areas far from edge, that have a high biomass of green vegetation, with some areas of bareground. Zimmerman (1971) determined that Dickcissels prefer old fields over prairies for nesting, presumably because of the taller vegetation, greater forb cover, and higher amounts of vegetation in old fields. We found similar results, because Dickcissels were related positively to Robel pole index, which is an indicator of biomass. As stated in the Final Report, Dickcissels may be expanding their range eastward and MTMVF mines may provide habitat for them. However, it is unknown if these birds are breeding on MTMVF mines.

Grasshopper Sparrow

Grasshopper Sparrow presence was negatively correlated to density of trees $>8-23$ cm (Table 1). This species prefers moderately open grassland and generally avoids areas with extensive shrub cover (Vickery 1996). They also appear to prefer areas with sparse vegetation and greater bareground cover (Vickery 1996). This was the most common species we encountered on the grassland treatment, occurring at 99% of point counts. Further information on Grasshopper Sparrow populations is reported elsewhere in this report.

Eastern Meadowlark

Presence of this species was negatively correlated to both density of trees $>2.5-8$ cm and shrub cover (Table 2). This species uses a variety of grassland situations, including pastures,

savannas, hay fields, roadsides, airports, and golf courses (Lanyon 1995). It appears to prefer areas with high grass and litter cover (Wiens and Rotenberry 1981). Our results indicate that the species prefers grassland areas that are more open with few trees or shrubs present. MTMVF mines provide habitat for this species for several years after reclamation, but as succession proceeds on the mines these areas will become unfavorable for them.

Red-winged Blackbird

Red-winged Blackbird occurrence was negatively correlated to shrub cover on our study areas (Table 2). Red-winged Blackbirds are found in a variety of habitats, such as field edges, marshes, roadsides, old fields, ditches, and pastures (DeGraaf and Rappole 1995). We commonly observed Red-winged Blackbirds in grasslands near created wetlands, stands of cattail (*Typha* spp.), and valleyfills on the mines. MTMVF mines appear to provide a considerable amount of habitat for this species, especially along the periphery of created wetlands.

Horned Lark

No habitat variables were selected by stepwise logistic regression to predict the presence of Horned Larks (Table 3). Horned Larks prefer open, barren areas with few trees and a minimum of vegetation (DeGraaf and Rappole 1995). We observed them most frequently in and along the roads on the mines. All detections of this species were at the Hobet and Daltex mines. Although presence was not related to any habitat variables, the species generally was present in areas with low tree densities (Table 3). Because Horned Larks prefer barren areas with little vegetation, MTMVF mines likely provide significant habitat for them during a short time span after reclamation, before grasses and forbs begin to develop a dense ground cover. After ground cover is established, Horned Larks will likely continue to use roads and barren areas on the mines.

Willow Flycatcher

No variables were selected by stepwise logistic regression for predicting the occurrence of Willow Flycatchers (Table 3). All of our detections of Willow Flycatchers were at the Hobet mine in blocks of autumn olive. Because none of our point counts were placed in blocks of autumn olive, we may not have been able to accurately determine the habitat factors important for predicting Willow Flycatcher presence. The edges of some autumn olive blocks were sampled during vegetation surveys, but entire blocks were never completely within a 50-m radius of the point count center. DeGraaf and Rappole (1995) report that the species occurs in a variety of habitats, including brushy fields, willow thickets, streamsides, shelterbelts, and woodland edges. However, they appear to prefer thickets or groves surrounded by grasslands, which is what we observed on the MTMVF sites. Based on our observations, it appears MTMVF mining will only provide habitat for this species if areas are planted with high densities of autumn olive. However, autumn olive is not a native plant and can become invasive and a nuisance; it is no longer recommended for planting in several counties.

Edge Species

White-eyed Vireo

We found the White-eyed Vireo to be positively related to density of trees >0-2.5 cm (Table 4), which is an expected result since this species prefers areas with low shrubby vegetation or brushy woodlands (DeGraaf and Rappole 1995). Denmon (1998) also found this species to be more abundant in areas with high shrub/sapling/pole density.

Yellow-breasted Chat

This species was found to be negatively associated to distance to habitat edge, and positively related to density of trees >0-2.5 cm and forb cover (Table 4). However, the logistic regression model failed the Hosmer-Lemeshow goodness-of-fit test. Chats prefer dense, shrubby areas with few tall trees (DeGraaf and Rappole 1995). Denmon (1998) found the species occurred more frequently in areas with a high density of stems >0-7.6 cm, which confirms our results.

Prairie Warbler

Presence of Prairie Warblers was negatively related to slope and distance from habitat edge, and positively related to litter depth, density of trees >23-38 cm, and percent green ground cover (Table 5). This species prefers areas with dense low trees, especially areas with some conifers (DeGraaf and Rappole 1995, Denmon 1998). We detected this species mostly in shrub/pole habitat, but it also was observed at grassland points where there were scattered shrubs and blocks of autumn olive nearby. MTMVF may provide more habitat for this species in the future if tree species return to areas reclaimed to grasses. However, the bird appears to prefer areas close to edge, and we often detected it along edges of forests. Thus, large, open expanses of grassland as occurs in MTMVF may be detrimental to the species.

Blue-winged Warbler

Blue-winged Warbler presence was positively associated with the density of trees >2.5-8 cm dbh (Table 5). Denmon (1998) observed this species more frequently in areas with a high density of trees from >0-7.6 cm and a low density of trees from 7.6-15 cm dbh. Thus, it appears from these results that Blue-winged Warblers are more likely to occur in areas where tree diameter growth has not yet reached 8 cm.

Common Yellowthroat

We found Common Yellowthroats to be positively related to density of trees >0- 2.5 cm and negatively related to density of trees >23-38 cm (Table 6). This species prefers areas with a mixture of small trees, and dense, herbaceous vegetation, typically in damp or wet situations (DeGraaf and Rappole 1995, Denmon 1998), and our results confirm this prediction. We commonly found them in shrubby areas around ponds on MTMVF mines (primarily Cannelton), along forest/mine edges, and in blocks of autumn olive.

Yellow Warbler

This species was detected more frequently at lower elevations and was positively related to litter cover (Table 6). It is a common and widespread species that prefers moist habitats (streamsides, bogs, swamps) with dense understories, typically of willow (*Salix* spp.) and alder (*Alnus* spp.) (DeGraaf and Rappole 1995). Denmon (1998) found a higher abundance of Yellow Warblers in grass/shrub-dominated habitat than in wooded, shrub-dominated, or thicket/shrub early successional habitats in West Virginia. Surprisingly, we did not detect this species on the Cannelton mine. It was observed most frequently at the Hobet mine in blocks of autumn olive, and it was detected in small wooded thickets at the Daltex mine. The Cannelton mine was at higher elevations than the other 2 mines, and this likely influenced the result showing this species to be negatively associated with elevation.

Indigo Bunting

This species was widely distributed, being observed at 86% of grassland and shrub/pole points combined, and at 94% of shrub/pole points alone. Stepwise logistic regression identified two variables, density of trees >2.5-8 cm and bareground/rock cover, as predictors of Indigo Bunting presence. They were positively correlated to tree density and negatively correlated to bareground/rock cover (Table 7). Indigo Buntings are found in a variety of edge situations:

along roadsides, in brushy old fields, old burns, wooded clearings, and brushy ravines (DeGraaf and Rappole 1995). They typically build their nests in a shrub or small tree.

Northern Cardinal

The Northern Cardinal was positively associated with the density of trees >2.5-8 cm (Table 7). Similar results were found by Denmon (1998), who found Northern Cardinals more frequently in areas with high shrub/sapling/pole density. She also found them in higher abundances in thickets with dense shrubs and small trees than in grass/shrub, shrub, or wooded early successional habitats. These results indicate that Northern Cardinals prefer advanced successional stages when young trees begin to dominate, but before the trees become too big and shade out lower-growing vegetation.

American Goldfinch

No variables were chosen by stepwise logistic regression for predicting presence of the American Goldfinch (Table 8). The only variable found by Denmon (1998) to be related to American Goldfinch presence was density of trees >15.0 cm, which was negatively related. Goldfinches typically use a variety of edge situations, including old fields and roadsides (DeGraaf and Rappole 1995).

Song Sparrow

This species was positively related to distance from habitat edge (Table 8). Of the points where this species was detected, 75% were at the Hobet and Daltex mines in grassland habitat, with a few low scattered trees and shrubs used for perching. Conversely, at the Cannelton mine, this species was only detected in shrub/pole habitat. Denmon (1998) only found herbaceous plant height to be positively related to Song Sparrow presence.

Chipping Sparrow

Chipping Sparrows were positively related to the density of trees >8-23 cm (Table 9), but the model failed the Hosmer-Lemeshow goodness-of-fit test and may not be valid. This species prefers open, wooded areas, forest edges, and clearings (DeGraaf and Rappole 1995), and our results confirm that they prefer areas with some large trees present.

Field Sparrow

This species was positively associated with density of trees >2.5-8 cm and negatively associated with bareground/rock (Table 9). Approximately 42% of the detections for this species were in grassland habitat, and the other 57% in shrub/pole habitat. This species uses small trees for song perches and will nest in them after leaf-out (Best 1978). They typically nest in grasses and forbs earlier in the season (Best 1978), which may be one reason they prefer areas with less bareground/rock. Denmon (1998) found them in higher abundances in grass/shrub, and shrub-dominated habitat than in thickets and wooded areas.

Eastern Towhee

Eastern Towhees were positively correlated to density of trees >8-23 cm (Table 10). Our results agree with Greenlaw (1996) who reported that this species occupies areas characterized by dense shrubs and small trees and appears to favor mid- to late- stages of succession with greatest densities in thickets and open-canopy woodland situations.

In summary, our results indicate that MTMVF mines are providing habitat for grassland and early successional songbird species in West Virginia in a region historically dominated by mature forest habitats. Many of these species would be rare or absent from this region if MTMVF mines were not present (see final report). However, it is not known if these populations

are breeding successfully on MTMVF mines. If reproductive success is low, then these mines could be acting as habitat sinks for these species.

Interior-edge and Forest-interior Species

Interior-edge species

American Redstart

Presence of this species was positively related to aspect code and negatively related to density of trees >2.5- 8 cm (Table 11). This is an adaptable species that breeds in a variety of forested situations including coniferous-deciduous woods, regenerating hardwoods, aspen groves, and shrubbery around farms and streams (DeGraaf and Rappole 1995). It is unlikely the MTMVF will have much affect on this species given the wide variety of habitats in which it will nest

Carolina Chickadee

Carolina Chickadee presence was positively related to trees >8-23 cm (Table 11). It is found in a variety of habitats, including deciduous woods, thickets, and suburban parks (Ehrlich et al. 1988). It is often seen near edges, and MTMVF mining could increase habitat for this species by increasing edge habitats.

Northern Parula

Northern Parula occurrence was positively associated with water cover and canopy cover >3-6 m and negatively associated with canopy cover >6-12 m (Table 12). This species is often associated with bottomlands, so it is not surprising that we found it to be related to water cover (DeGraaf and Rappole 1995). We commonly found this species near drainages in forested fragments and intact forest, and it does not appear to avoid edges.

Carolina Wren

Presence of this species was negatively related to aspect code and to density of trees 2.5 –8 cm (Table 12). This species is found in a variety of wooded situations, including brushy bottomlands, open deciduous woods, and parks (Ehrlich et al. 1988).

Downy Woodpecker

The occurrence of Downy Woodpeckers was positively associated to aspect code (Table 13). This bird is often found near edges and inhabits deciduous and mixed-deciduous stands, riparian stands, and parks (Ehrlich et al. 1988). MTMVF mining could potentially increase habitat for this species by increasing edge habitats, but the reduction in forest cover by MTMVF mining could also have a negative impact on the species.

Tufted Titmouse

Tufted Titmouse occurrence was positively associated with green ground cover (Table 13). Like the Carolina Chickadee and Downy Woodpecker, this species inhabits a variety of wooded situations, often being seen in parks, open deciduous woods, and edges (Ehrlich et al. 1995).

Red-bellied Woodpecker

The presence of this species was negatively associated to canopy cover >24m. (Table 14). Red-bellied Woodpeckers primarily inhabit deciduous woods, but are also found on edges, in parks, and suburban situations (Ehrlich et al. 1988). Impacts of MTMVF mining on this species would likely be minimal because of its generalist nature.

White-breasted Nuthatch

No variables were selected by stepwise logistic regression for predicting the presence of this species (Table 14). Although this species is often found on edges and in suburban and park situations, it appears to prefer forests with large, old, decaying snags (Ehrlich et al. 1988). MTMVF mining could increase edge habitat for this species, but ultimately it could have negative effects on the species if large, dead snags are not present.

Forest-interior species

Ovenbird

Ovenbird presence was positively associated with bareground/rock cover and negatively associated with canopy cover from >3-6 m. (Table 15). This species prefers extensive, open, mature forests without thickets and tangles, with “an abundance of fallen leaves, logs and rocks” (DeGraaf and Rappole 1995), and our results agree with this assessment. This species was found to be less abundant in forests fragmented by MTMVF mining, and could be detrimentally impacted if MTMVF mining continues.

Black-throated Green Warbler

The Black-throated Green Warbler was negatively related to density of trees >8-23 cm (Table 15). DeGraaf and Rappole (1995) state that this species inhabits “large stands of mature open mixed woodlands (especially northern hardwood-hemlock stands).” Our observations agree with this assessment. We most frequently encountered Black-throated Green Warblers in stands of hardwoods intermixed with eastern hemlock, along streams in mature woods.

Pileated Woodpecker

The presence of the Pileated Woodpecker was negatively associated to canopy cover >24 m (Table 16). This large woodpecker prefers deciduous woods with large trees, but it also is found on edges and in parks and suburban situations (Ehrlich et al. 1988).

Yellow-throated Warbler

Presence of this species was negatively associated with aspect code, indicating a preference for drier slopes and ridges, and negatively associated with canopy cover from >12- 18 m (Table 16.) This species is often found along streams and rivers, typically in large, tall trees of bottomland hardwood forests, however, it also is often found in stands of pine, oaks, or mixed forests (DeGraaf and Rappole 1995). Most of our detections of this species were on ridge tops dominated by oak species.

Summer Tanager

No variables were selected by stepwise logistic regression for predicting the occurrence of Summer Tanagers (Table 17). This species is typically found in dry, open woodlands of oak, pine, and hickory in the southeast, but may also be found in bottomlands in the north (DeGraaf and Rappole 1995).

In summary, for most interior-edge species, MTMVF mining may have mixed impacts on their populations. MTMVF mining would create more edge for these species, but it would also decrease the amount of mature forest, which these species also require. The least-impacted species would likely be resident species such as the woodpeckers, chickadees, and titmice that use a variety of habitats. Forest-interior species would most likely be negatively impacted if the amount of forest cover continues to be reduced without any subsequent reforestation.

B. Grasshopper Sparrow Habitat and Nesting Success

Songbird species that require grassland and other early successional habitats were observed and documented on reclaimed MTRVF mines, some at relatively high densities Wood et al. (2001). Grasshopper sparrows (*Ammodramus savannarum*), in particular, were very abundant and were successfully breeding on the sites. However, nesting success data from 1999-2000 was limited and we felt that no conclusions could be drawn from the data. The objectives of this study are to continue examining habitat and nesting requirements and nesting success of Grasshopper Sparrow populations colonizing reclaimed MTRVF mine sites in southern West Virginia.

Methods

Study areas are the same three MTRVF mine sites in southwestern West Virginia that were investigated by Wood et al. (2001). The Hobet 21 mine is located in the Mud River watershed in Boone County, the Daltex mine is located in the Spruce Fork watershed in Logan County, and the Cannelton mine is located on the border of Kanawha and Fayette counties in the Twentymile Creek watershed. Two 40 ha sample plots were established on each mine complex, (Hobet Adkins (HA1), Hobet Sugar Tree (HN2), Daltex Rock house (DR1), Daltex Spruce Fork (DN2), Cannelton Lynch Fork (CL1), and Cannelton (CV2)) for a total of six search areas. Additional nest plots were established for nests found on mine complexes but not within sample plots, (Daltex off plot (DO1) and Hobet off plot (HO1)).

Adult male and female Grasshopper Sparrows were captured on each study site with mist nets and conspecific song playback from April 2001 to July 2001. All captured individuals were banded with Fish and Wildlife Service bands. Basic physical information (sex, weight, wing cord measurements, and overall condition) was recorded, and then each individual was marked with a unique combination of two colored plastic bands for future identification. Juveniles were similarly processed and marked with a single colored band prior to fledging from the nest.

Nest searching and habitat sampling methodologies are similar to those previously presented in Wood et al. (2001). Briefly, nest searching was conducted on two 40-ha nest search plots in reclaimed grassland areas of Hobet 21 (HA1 & HN2), Daltex (DR1 & DN2), and Cannelton (CL1 & CV2) mine sites for a total of six search areas. Eight fixed vegetation-sampling sub-plots were systematically selected and surveyed on each search plot (N=48) to examine differential nest site selection preferences in this species.

To obtain a good estimate of species-specific nest survival, a minimum of 20 nests must be monitored (Martin et al. 1997). Therefore, I set a target of 25-30 nests for Grasshopper Sparrows nesting in the grassland habitat of the study sites. Field personnel trained in proper searching and monitoring techniques (Martin and Geupel 1993) searched each nesting area every 3-4 days. Nest searching began one-half hour after sunrise and concluded 8-10 hr later (approximately 0600-1600 EST). Nest searching methods followed national BBIRD (Breeding Biology Research and Monitoring Database) protocols (Martin et al. 1997). To control for search effort, nests were located by systematically searching study plots.

All Grasshopper Sparrow nests found were monitored every 3-4 days (Martin et al. 1997) to confirm activity. Because Grasshopper Sparrow nests are typically well concealed within vegetation, they were marked for relocation using a staked flag placed at a minimum distance of 15m from the nest. Care was taken when monitoring the nest to avoid disturbing the female.

When possible, nest searchers observed the nest from a distance of no less than 15 m for up to 30 min to confirm that it was still active. Each nest was approached and visually checked for contents a maximum of four times: once when it is initially found, once to confirm clutch size, once to confirm brood size, and once to confirm fledging success or failure. Nests were not approached when avian predators (e.g., American Crows and/or Blue Jays) were observed nearby because these birds are known to follow humans to nests (Martin et al. 1997). Observers also continued to walk in a straight line after visually observing nest contents to avoid leaving a dead-end scent trail directly to the nest that might be followed by mammalian predators (Martin et al. 1997). The vegetation concealing the nest was moved to the side using a wooden stick to avoid putting human scent on the nest if the vegetation blocks the observer's view of the contents.

A nest was considered successful if it fledged at least one young. Fledging success was confirmed by searching the area around the nest for fledglings or for parent-fledgling interactions. However, if no fledglings were observed, the nest was considered to have fledged young if the median date between the last active nest check and the final nest check when the nest was empty and was within two days of the predicted fledging date (Martin et al. 1997). Nest survival was calculated using the Mayfield method (Mayfield 1961, Mayfield 1975). Daily nest survival estimates were calculated for the incubation and brooding periods separately because there might be differential nest survival between these two periods. The overall daily survival rate was calculated as the product of incubation and brood daily survival. Survival during the egg-laying stage will not be included in the calculation of overall nest survival because few nests were located during this stage of the nesting cycle.

After each nest fledged or failed, vegetation within an 11.3 m radius circle surrounding the nest was sampled to determine habitat characteristics important to nest survival. We measured vegetation for each nest monitored using methods modified from James and Shugart (1970) and the Breeding Bird Research Database program (BBIRD; Martin et al. 1997). These included estimates of percent ground cover in nine cover types (grass/sedge, shrub/seedling, fern, moss, bare ground, forb/herbaceous, woody debris, litter, and water). Percent ground cover was estimated using an ocular sighting tube (James and Shugart 1970). The sight-tube was a 5.0-cm pvc pipe with cross-hairs at one end. Five sight-tube readings were taken on each subplot every 2.26 m along four, 11.3-m transects that intersected at the center of the subplot. The percentage of each cover type present in the sight-tube was estimated and recorded. Grass height and organic litter layer depth were measured at 13 locations along the 4 transects: at the center and at distances of 1 m, 3 m, and 5 m along each transect. A Robel pole (Robel et al. 1970) was used to calculate an index of vegetative cover and an index of biomass (Kirsch et al. 1978). Additional nest measurements including percent slope, slope orientation, nest height (cm), width and depth of nest rim and cup (cm), nest substrate height (vegetative and reproductive), and distance to foliage edge were surveyed to examine differences among individual nests. Habitat and nest variables were tested for differences among nests and habitat plots using one-way analysis of variance (ANOVA) ($\alpha=0.05$) (Zar 1999).

Results and Discussion

A total of 202 Grasshopper Sparrows were captured, banded, and processed on the MTRVF study sites during the 2001 breeding season. Mist netting effort resulted in an overall capture rate of 0.25 captures per net hour with 193 captures in 785.63 hours (Table 18). Juveniles that were banded in and around nests (N=9) were not included in the mist net capture effort calculations. An additional 45 non-target individuals were captured on the study plots with the

most common species including Eastern Meadowlark, Field Sparrow, Indigo Bunting, and Savannah Sparrow.

Systematic searches of study plots produced 37 active Grasshopper Sparrow nests on the three mines surveyed. Overall nest search effort was one nest per 10.06 hours of effort for all sites combined (Table 19). Nests found opportunistically off of the study plots (N=4) are not included in search effort calculations because they were not located by systematically searching study areas. Mean clutch size (Table 19) for the surveyed nests was 3.73 ± 0.16 and is similar to those reported in the literature (Wray et al. 1982, Ehrlich et al. 1988). Grasshopper sparrow nest survival for 2001 breeding season (30%) is comparable to survival rates previously reported on these study sites (36.4%) (Wood et al. 2001). Nest survival for this species reported from other areas has ranged from 7-41% as summarized in Wood et al. (2001).

Comparisons of habitat variables surrounding successful (n=17) and unsuccessful (n=20) nests (Table 20) indicate no significant differences among slope, aspect, distances to nearest minor edge, ground cover variables, grass height, and litter depth. Significant differences were detected in the Robel pole index at the nest ($F=6.56$, $P=0.01$) and at 1 meter from the nest ($F=6.68$, $P=0.01$). These analyses suggest that less dense vegetation near the nest may be an important factor in nest success.

Comparisons of habitat variables measured at nests (N=37) and at the fixed habitat plots (N=48) suggest differences in several of the ground cover estimates (Table 21). Percent green ($F=574.53$, $P<0.0001$) and percent grass ($F=26.25$, $P<0.0001$) estimates were significantly lower at the nest plots while percent bare ground ($F=24.73$, $P<0.0001$), percent litter ($F=7.65$, $P=0.01$) and percent moss ($F=3.05$, $P<0.0001$) was significantly higher at nest plots. These findings support previous studies that suggest Grasshopper Sparrows require a high degree of bare ground associated with nesting sites for foraging (Whitmore 1979, Wray et al. 1982). Significant differences were also detected in the Robel pole index for all comparisons (all <0.0001), with nests placed where vegetation density was greater than generally available on the plot. No differences were detected in grass height comparisons except at the five-meter distance from sample plot centers ($F=7.78$, $P=0.0056$). Litter depth differed significantly between the fixed habitat plots and nest plots at all measured distances.

In summary, data suggest that the large reclaimed grassland habitats available on the mountaintop removal/valley fill mine complexes surveyed in this study are sufficient to support breeding populations of Grasshopper Sparrows with nest success rates similar to populations found in other grassland habitats. Important nesting habitat characteristics included patches of dense grassland vegetation interspersed with patches of bare ground. These habitat conditions support high densities of breeding Grasshopper Sparrows, even on newly reclaimed sites. As ground cover develops, however, sites will become unsuitable for Grasshopper Sparrows unless habitats are managed to maintain the required conditions.

C. Small Mammal Sherman Trapping Data

Additional analyses were completed on small mammal data collected through Sherman trapping to assess differences in habitat quality among treatments, as abundance alone is not necessarily a reliable indicator of habitat quality for a given species. Some studies have suggested that reclaimed lands may act as a population sink for *Peromyscus* and that adjacent unmined lands may provide superior breeding and foraging habitat (DeCapita and Bookout 1975). As a measure of habitat quality, we compared the proportion of adult *Peromyscus* spp.

individuals that were in breeding condition among treatments (within a year) and between years (within a treatment) (Table 22), where mice weighing 16 g or more were considered adults (Whitaker and Hamilton 1998). In 1999, a significantly greater proportion of males and females were in reproductive condition in the grasslands than in either of the forest treatments. In 2000, only females had significant differences among the 4 treatments sampled; a lower percentage of individuals were in reproductive condition in the intact forest than in the other 3 treatments. These results generally followed the abundance trends, suggesting that reclaimed areas were not acting as population sinks on our study sites, but were actually more productive breeding sites than adjacent forests. Reclaimed areas appear to be better breeding habitat for *Peromyscus* probably due to their greater biomass of grasses, forbs, and invertebrates. Reproductive condition differed between the 2 years of the study in the two forest treatments, but not in the grasslands. A higher proportion of both males and females in fragmented forest were in reproductive condition in 2000 than in 1999. In the intact forest, differences between the years were found in males but not in females. In all cases of between year differences, the proportion of reproductive individuals was greater in 2000 than in 1999, suggesting that the 1999 summer drought may have reduced the reproductive rates of *Peromyscus*, or that the moist and mild summer weather in 2000 may have improved conditions for breeding. These differences may have been a function of the greater plant biomass in 2000 than 1999.

Peromyscus spp. abundance was compared among treatments by age and sex groups (adult male, adult female, juvenile male, and juvenile female). In 1999, adult males were more abundant in grassland than in fragmented or intact forest and adult females were more abundant in grasslands than in intact forest (Table 23). In 2000, for adult males, adult females, and juvenile females, the grassland and shrub/pole treatments were similar, but had significantly greater abundances than fragmented forest and intact forest, which were also similar to each other. These differences, which followed overall *Peromyscus* abundance trends, suggested that early-successional areas (i.e. grassland and shrub/pole treatment) provided habitat that was superior to the forested areas. We also compared juvenile abundance, as it is an indicator of reproductive success of adults in a treatment. We found no differences among treatments in 1999, but in 2000, differences were found among treatments for both males and females. Juvenile males were more abundant in grasslands than in either forest treatment and greater in shrub/pole than in the fragmented forest treatment. Juvenile females were greater in the grassland and shrub/pole treatments than in the 2 forested treatments. As with adults, results generally followed overall *Peromyscus* abundance trends.

Habitat and environmental variables were used in regression analyses to identify factors that were predictive of small mammal richness and abundance. The grassland treatment was analyzed separately from the other three treatments in the regression procedures because it had several habitat variables not recorded in the other treatments due to considerably different vegetation structure. Stepwise multiple linear regression was used for *Peromyscus* spp. abundance, total small mammal abundance, and species richness, while logistic regression was performed on presence/absence data of less commonly captured species (house mice in grasslands and short-tailed shrews, woodland jumping mice, and eastern chipmunks in the other three treatments). In both types of regression, an entry level of 0.30 and a stay level of 0.10 was used. Environmental variables incorporated into the regression models included precipitation (cm) (National Oceanic and Atmospheric Administration/National Weather Service, Charleston, W. Va.) averaged over the 3-night trapping session, low temperature (°C) (NOAA/NWS, Charleston, W. Va.), moon phase expressed as a percentage of moon's surface illuminated (Astronomical Applications Department, US Naval Observatory), and an index of nighttime ambient light. The ambient light index was calculated as a product of the percentage of the moon's surface illuminated and cloud cover (NOAA/NWS, Charleston, W. Va.) on a scale

of 1 (clear skies) to 0.1 (overcast). Habitat variables included those described in the original project report (Wood et al. 2001).

In multiple linear regression analysis for shrub/pole, fragmented forest and intact forest treatments, daily low temperature and precipitation were negatively related to species richness, and the percentage of bareground was positively related (Table 24). Relationships were weak as no single variable contributed a partial R^2 of more than 0.10. Several variables were significant predictors of total small mammal abundance. Of these, canopy cover from 0.5-3m was negatively related and contributed the most to the model (partial R^2 of 0.21). Canopy cover from 0.5-3m also was the most important predictor of *Peromyscus* spp. abundance, with a partial R^2 of 0.31. Generally, *Peromyscus* spp. had greater abundance at sites with less low canopy cover, lower canopy height, more bare ground, and when precipitation during the trapping period was not heavy.

Average grass height was the only variable related to richness in grasslands, based on multiple linear regression analysis; it was a positive relationship with a partial R^2 of 0.24 (Table 25). Areas with taller grass may have held more species because they provided better cover and more forage for small mammals. Three variables were positively related to total abundance, with the amount of green groundcover being the strongest (partial $R^2=0.37$). Precipitation was a positive predictor and the percentage of bareground was a negative predictor, though both relationships were weak. For *Peromyscus* spp. abundance, bareground had a strong negative relationship, with a partial R^2 of 0.45. It is likely that *Peromyscus* spp. avoid areas of bareground to avoid exposure to predators. In addition, precipitation and the number of shrub stems were weak positive predictors of *Peromyscus* spp. presence.

Presence of short-tailed shrews in shrub/pole, forest fragment, and intact forest treatments, was positively related to the percentage of bare ground in the logistic regression model (Table 26). This was contrary to expectations as shrews generally seek cover (Whitaker and Hamilton 1998). Moon illumination had a negative relationship with the presence of woodland jumping mice, while water as a groundcover and canopy cover from 0.5-3m had a positive relationship. Many small mammals species are less active when the moon is bright, presumably to avoid predation (Kaufman and Kaufman 1982). For chipmunk presence, 4 variables contributed significantly to the regression model. Water as a groundcover had a negative relationship, and bareground, canopy cover above 12m, and stem density of trees from 8-38 cm DBH had positive relationships with abundance. The preference for larger, taller trees may be due to their reliance on mast as a food source. In the grassland treatment, average grass height was the only significant variable; it was a positive predictor for the presence of house mice.

D. Small Mammal Data from Herp Arrays

Small mammals were trapped in pitfall and funnel traps associated with drift-fence arrays targeting herpetofauna. Estimates of species richness and abundance of 9 species were calculated based on 13 trapping sessions conducted between March 2000 -October 2001. Analysis of variance (ANOVA) was used to detect differences among treatments. The model included treatment and trapping session as the main factors and a treatment by session interaction term. If the ANOVA found that means were different, a Waller-Duncan k-ratio t-test was used to compare means among treatments.

Species richness of small mammals was significantly lower in the intact forest treatment than in the other 3 treatments (Table 27). Richness estimates were different from those of Sherman trapping which found that richness did not differ among treatments in either 1999 or 2000 and were generally much lower than array estimates. The difference between the 2 estimates is most likely due to the fact that Sherman trapping is not effective at capturing *Sorex* spp. because shrews generally are not heavy enough to spring Sherman traps and, as insectivores, they are less likely to be attracted to the peanut butter and oat bait. For this reason, the estimates of richness from the drift-fence arrays are likely to be a more accurate reflection of the species present in each treatment (Kirkland 1994).

Similarly, total abundance of small mammals captured in herp arrays (Table 27) was significantly lower in the intact forest treatment than in the other 3 treatments. Sherman trapping data found that the 2 reclaimed treatments were similar in abundance to each other and greater than the 2 forest treatments, which also were similar to each other. The difference in total abundance trends between the 2 methods likely was that *Peromyscus* spp. dominated Sherman trapping results (87% of captures), driving trends in total abundance. Sherman trapping is more effective for catching mice than drift fence arrays because Sherman traps are baited. For this reason, Sherman trapping resulted in many more *Peromyscus* per 100 trap nights than drift fence arrays.

The greater richness and abundance in reclaimed areas than in intact forests was similar to the findings of Kirkland (1977) in a study comparing richness and abundance of small mammals among different aged clearcuts on the Monongahela National Forest in West Virginia. He found that there was an initial increase in the diversity and abundance of small mammals in response to clearcutting that persisted until the area succeeded back into forest. He speculated that the increased herbaceous vegetation layer created by openings improved foraging habitat for small mammals.

The only significant difference in *Peromyscus* spp. abundance among treatments was between grasslands and intact forest, with grasslands having the higher abundance (Table 27). Most previous studies have also found that *Peromyscus* spp. benefit from disturbances that create early-successional habitats such as mining (Verts 1957, Mumford and Bramble 1969, DeCapita and Bookout 1975, Kirkland 1976, Hansen and Warnock 1978) and forest clearcutting (Kirkland 1977, Buckner and Shure 1985). Sherman trapping results from 2001 were slightly different, with the 2 reclaimed treatments having higher abundances than the 2 forest treatments. Again the results differ between the 2 methods because Sherman trapping is more effective at capturing *Peromyscus* spp.

Three species of microtine rodents, southern bog lemmings, woodland voles, and meadow voles, were captured by drift fence arrays (Table 27). Southern bog lemmings were the most common of these (86 individuals). Their abundance was higher in the two reclaimed treatments than in the forest treatments, while they were not captured at all in the intact forest. This was consistent with other accounts of the bog lemming. Kirkland (1977) described capturing bog lemmings in clearcuts but not in either deciduous or coniferous forests and Connor (1959) found them to be reliant on sedges and grasses for a food source. Woodland voles (47 individuals) were less abundant in grasslands than in intact forests. Despite their name, woodland voles can be found in a variety of habitats, including forests, orchards, and dry fields (Whitaker and Hamilton 1998). However, in a laboratory study, woodland voles chose sites with cooler, more organic soils over warmer, rocky soils (Rhodes and Richmond 1985). This may explain their lower numbers in the grassland treatment, where soils were likely too warm and rocky for them. Meadow voles, the least frequently captured of the microtines (22 individuals), did not differ in

abundance among treatments. This may have been a function of having a small sample size and the fact that this species is a habitat generalist (Whitaker and Hamilton 1998).

Woodland jumping mice and short-tailed shrews were significantly more abundant in fragmented forest than in the other 3 treatments (Table 27). We did not find any other research suggesting that these species prefer fragmented forests to intact forests. For woodland jumping mice, however, Sherman trapping data concurred with this abundance trend. Woodland jumping mice are reported to prefer dense understory (Whitaker and Wrigley 1972) and are often found near forest streams (Whitaker and Hamilton 1998). Similarly, short-tailed shrews are known to prefer moist, cool sites (Getz 1961) because they have a high rate of evaporative water loss through their skin. Fragmented forest transects tended to follow slightly larger streams than did intact forest transects; consequently presence of water may have been driving greater abundance of these species (as described in section C above).

Three shrew species of the genus *Sorex* were captured in all 4 treatments: masked shrews, smoky shrews, and pygmy shrews (Table 27). Masked shrews, the most common of the 3, were more abundant in the shrub/pole treatment than in either forest treatment and were more abundant in the grassland treatment than the intact forest treatment. This species is a habitat generalist that exists in just about any habitat so long as it is moist (Moore 1949). Smoky shrew abundance did not differ among treatments. This species typically is found in damp woods (Caldwell and Bryan 1982) and was not expected to occur in grasslands. The high rainfall during spring - summer 2000 may have allowed smoky shrews to exist in grasslands that would otherwise have been too hot and dry. Pygmy shrew abundance was greater in the fragmented forest than in the shrub/pole treatment. The smallest of the shrews, this species usually is found in upland woods (Whitaker and Hamilton 1998). Small sample size (16 individuals) limits interpretation of trends in abundance for this species.

E. Herpetofaunal Surveys

Drift fence arrays established and sampled in 2000 were sampled again in 2001 using methods described in Wood et al. (2001). Arrays were opened for approximately eight days each month from March through October (excluding April). In 2001, an additional intact sampling array was added near the Daltex mine in Pigeonroost Hollow; it was sampled September and October.

In 2001, we also initiated a pilot project to assess aquatic herpetofaunal diversity and abundance in intact forest streams not impacted by mining and in fragmented forest streams located below valley fills.

Methods

Stream Searches – Sampling Techniques

To quantify aquatic and semi-aquatic herpetofaunal diversity and abundance, three fragmented forest streams and three intact forest streams were sampled once per month in May, June, and August -October of 2001. In addition, another forest fragment stream was added and sampled in September and October 2001. Streams were selected based on proximity to the drift fence arrays. Fragmented forest streams were located below valley fills.

A different 35-m segment was sampled in each stream each month. By moving down and sampling new, adjacent stream segments, the intention was to sample as much of the entire length of each stream as possible. Searching more than 35 m per visit is not practical, as some segments require several hours of search time due to their complex substrate. Each segment sampled was classified by stream order (intermittent, first order, second order, or third order) and by predominant structures (Table 28). Stream order was determined from topographic maps using the following definitions from the Federal Interagency Stream Restoration Working Group (1998; pages 25-26). "The uppermost channels in a drainage network (i.e., headwater channels with no upstream tributaries) are designated as first-order streams down to their first confluence. A second-order stream is formed below the confluence of two first-order channels. Third-order streams are created when two second-order channels join, and so on." Fragmented forest streams located below valley fills were assigned the stream order that they would have had before mining occurred.

Herpetofaunal sampling methods in streams were similar to those of Crump and Scott (1994). All rocks and coarse woody debris located within the width of the stream were lifted and checked under for herpetofauna. In addition, all rocks and coarse woody debris found up to 1-m from the edge of the stream were also sampled. A count was kept of all rocks and coarse woody debris checked under during the sample (Table 28). Time in person minutes was recorded, as were species, length of salamanders from snout to anterior portion of vent (cm) (done by placing salamander in a Ziploc bag); and length (cm), width (cm), and type of substrate (e.g., rock) under which the animal was found (Table 28). In addition, soil temperature in the stream (°C) was measured using a REOTEMP Heavy Duty Soil Thermometer (Ben Meadows Company) and air temperature (°C) was determined using a -30 to 50 °C / 1° Pocket Thermometer (Ben Meadows Company). Individuals were toe-clipped for identification of recaptures. Cover objects that would cloud the water with bottom substrate upon lifting are not included in the sample, as any salamanders would escape capture before their presence could be detected.

Data Analyses

Only data from drift fence arrays were subjected to statistical analyses. To account for differences in the lengths of trapping periods and in trap effort (an unequal trapping effort resulted from theft of traps, weather conditions rendering traps nonfunctional, etc.), the sum of the number of animals captured in all pitfall and funnel traps at each array during a trapping period was divided by the number of operable traps over the trapping session. This value multiplied by 100 equaled mean captures per treatment in 100 array-nights (Corn 1994).

ANOVA was used to compare mean captures among treatments. Dependent variables were mean abundance of: 1) all herpetofauna, 2) major groups (e.g., salamanders, toads and frogs, etc.), 3) all amphibians, 4) all reptiles, and 5) individual species with high enough captures (≥ 30). Main effect independent variables were treatment, year, sampling period, and mine. All anova tests excluded data from the new intact forest point because it was sampled for only 2 months in 2001; all other summary tables include this information.

Results and Discussion

Over the 2 years of sampling (2000 and 2001), 1750 individuals were captured or observed using drift fence arrays, stream searches, and incidental sightings. Of a possible 58 species expected to occur in the study area, we encountered 41 (Table 29), an increase of 6 species from 2000. The 41 species included 12 salamander species, 10 toad and frog species, 3 lizard species, 13 snake species, and 3 turtle species.

A total of 625 individuals and 32 species were captured using drift fence arrays over the 2 years (Table 30) including 10 salamander species, 9 toad and frog species, 3 lizard species, 9 snake species, and 1 turtle species. Fifteen of these species are classified as terrestrial, 10 are semi-aquatic, and 7 are aquatic.

Overall mean abundance of herpetofauna did not differ among the four treatments ($F=1.62$, $df=3$, $P=0.28$; Table 31). Mean richness also was not different among treatments ($F=0.86$, $df=3$, $P=0.51$; Table 31). In a study in Pennsylvania, Yahner et al. (2001) inventoried herpetofauna in forest, riparian, and grassland habitats using 8 different survey methods, including drift fence arrays. Forest habitat produced the highest number of individuals, whereas grasslands yielded no captures. Pais et al. (1988) conducted a study in eastern Kentucky, where the herpetofaunal community is similar to that on our sites. Using techniques similar to ours (drift fences in conjunction with pitfalls and funnel traps), they found no difference in total captures of herpetofauna among clearcuts, mature forest, and wildlife clearings, although herpetofaunal richness was lower in mature forest than in clearcuts and wildlife clearings. Although clearcuts can resemble reclaimed mine sites in vegetation structure, the magnitude of soil disturbance is greater on reclaimed sites.

Abundance was not different among the four treatments when species were categorized into terrestrial ($F=0.81$, $df=3$, $P=0.53$), aquatic ($F=1.87$, $df=3$, $P=0.24$), and semiaquatic herpetofauna ($F=0.30$, $df=3$, $P=0.82$; Table 31). Amphibian abundance also did not differ among the four treatments ($F=1.09$, $df=3$, $P=0.42$), nor did reptile abundance ($F=2.09$, $df=3$, $P=0.20$). Adams et al. (1996) found a higher abundance and species richness of reptiles in disturbed habitat (clearcuts) than in unharvested stands.

Salamander abundance was not significantly different across treatments ($F=4.26$, $df=3$, $P=0.06$), although it was generally higher in the 2 forested treatments (Table 31). This taxonomic group comprised 22-38% of captures in forested treatments and approximately 7% in grassland and shrub/pole treatments (Table 32). Number of species was higher in forested treatments. The red-spotted newt was the most abundant salamander and was the only salamander species found at every sampling point (Table 30). Both the red-spotted newt and the spotted salamander were found in every treatment. The only other salamander species found in reclaimed habitat was the four-toed salamander, which was captured in grassland and shrub/pole treatments. Both the spotted salamander and the four-toed salamander require moist forests, so the individuals found at a grassland point may have been migrating to a nearby wet area or forested habitat. The shrub/pole point at which a spotted salamander was captured is particularly wet compared to all other treatment points; pitfalls are often rendered nonfunctional due to the ground water pushing them up and out of the ground.

Forests tend to have cooler, moister, and more homogeneous climatic conditions than grasslands and should therefore better meet the habitat requirements of salamanders. Increased insolation and reduction in soil moisture retention associated with grassland habitat may limit the ability of a salamander to forage. Native vegetation removal alters rainfall

interception rates and evapotranspiration, thereby additionally affecting soil moisture levels (Kapos 1989). In a review of 18 studies of amphibian responses to clearcutting, deMaynadier and Hunter (1995) found that amphibian abundance was 3.5 times higher in unharvested stands than in recent clearcuts. Other studies not covered in this review have found decreased abundance (Buhlmann et al. 1988, Sattler and Reichenbach 1998, Harpole and Haas 1999) or that responses are species-specific (Cole et al. 1997, Grialou 2000). Ross et al. (2000) found salamander richness and abundance to decrease as a function of increasing removal of live tree basal area. Ash (1997) observed an initial decrease in salamander abundance following clearcutting, but found that within 4-6 years, it returned to preharvesting levels and then proliferated. Because mining results in greater soil disturbance, however, salamander populations may take longer to recover on reclaimed sites than reported by Ash. Generally for salamanders, high site fidelity, small home ranges, physiological limitations, low fecundity, and the inability to traverse large distances quickly make them especially susceptible to effects of forest alterations (Pough et al. 1987, Petranka et al. 1993, Petranka et al. 1994, Blaustein et al. 1994, Droege et al. 1997, Gibbs 1998b, Ross et al. 2000).

Toads and frogs showed no difference in abundance among the treatments ($F=0.89$, $df=3$, $P=0.50$; Table 31). This taxonomic group was consistently present in the highest numbers in each treatment, comprising from 44-73% of all individuals captured within treatments (Table 32). The green frog was the only anuran species captured at every sampling point (Table 30). Both eastern American toads and pickerel frogs were captured in every treatment (Table 29). The green frog and the pickerel frog were the most abundant species in this study (Table 30), totaling 45% of all captures. Toads and frogs are more tolerant of temperature extremes than salamanders (Stebbins and Cohen 1995), and thus can occur in non-forested habitats. Ross et al. (2000) found toad and frog richness to have a positive relationship with increases in tree basal area.

Snakes varied from 12-28% of captures in each treatment (Table 30). Five species were found in all four treatments: black rat snake, eastern gartersnake, eastern milk snake, northern black racer, and northern copperhead. Snakes also showed no difference in abundance across treatments ($F=2.08$, $df=3$, $P=0.2039$; Table 31). Ross et al. (2000) found snake abundance and species richness to be inversely related to tree basal area. Forested habitat is preferred or required by four snake species captured in this study; one prefers grasslands, and four can be found in a variety of habitats (Behler and King 1995, Green and Pauley 1987, Conant and Collins 1998). The four ubiquitous species comprised the majority of snake captures (82%), which could explain why abundance was not different among treatments.

Lizards were not captured in high enough abundance to conduct statistical analyses; they made up only 2-3% of total herpetofauna captured in each treatment (Table 32). Three of the five lizard species expected to occur in our study area were captured in drift fence arrays (Table 29); they included three northern-fence lizards, eight common five-lined skinks, and two little brown skinks. While only three fence lizards were captured, this species was commonly sighted in all treatments except intact forest). Because this species is not typically found in moist forests, it may not have been abundant on the study sites prior to mining. The little brown skink is classified as an S3 species by the West Virginia Natural Heritage Program (2000) meaning that there are only 21 to 100 documented occurrences in the state and that it may be under threat of extirpation. It prefers dry, open woodlands and uses leaf litter and decaying wood for concealment and foraging (Green and Pauley 1987, Conant and Collins 1998). Captures occurred in pitfalls, one in grassland habitat and the other in intact forest (Table 29). Leaf litter is present in negligible amounts and CWD is absent from our grassland sampling points (Table 33), so grassland habitats generally would not be suitable for little brown skinks.

Turtles also were not captured in high enough abundance to conduct statistical analyses. Only one species of turtle, the eastern box turtle, was captured in the arrays (Table 29). Eastern box turtles seldom are captured in pitfall traps and may have a natural wariness of pitfalls (Pais et al. 1988). Furthermore, they are too large to fit through the entrance of funnel traps used in this study. As this species was commonly sighted as an incidental and was found in every treatment, it probably has fairly high population numbers on the study sites.

Six species had ≥ 30 individuals captured, so abundance was compared among treatments (Table 31). The northern black racer had highest abundance in the shrub/pole treatment and did not occur in the forest fragment and intact forest treatments ($F=4.79$, $df=3$, $P=0.05$). The Florida king snake (*Lampropeltis getula floridana*) benefited from conversion of its native habitat (cypress ponds, savannah pine lands, and prairies) to sugarcane fields. This conversion increased prey density and provided additional shelter for the snakes with the creation of limestone dredge material along the banks of the irrigation canals (Pough et al. 2001). Perhaps the creation of riprap channels and rock chimneys in reclaimed habitat has served the northern black racer population on mountaintop mines in a similar way. Abundance of the eastern American toad ($F=1.09$, $df=3$, $P=0.42$), red-spotted newt ($F=1.62$, $df=3$, $P=0.28$), northern green frog ($F=1.78$, $df=3$, $P=0.25$), pickerel frog ($F=1.30$, $df=3$, $P=0.36$), and eastern gartersnake ($F=0.34$, $df=3$, $P=0.80$) did not differ among the four treatments. Other studies have found the red-spotted newt to be sensitive to forest fragmentation (Gibbs 1998a) and forest edge (Gibbs 1998b). However, similar to our study, deMaynadier and Hunter (1998) looked at even-aged silvicultural treatments (clearcuts and conifer plantations) and did not find a difference in newt abundance between these treatments and the bordering mature forest. Ross et al. (2000) observed a positive association of eastern garter snakes with forest stands containing negligible amounts of residual tree basal area.

Several species captured or detected during the 2 years of the study are listed as S2 or S3 status by the West Virginia Natural Heritage Program (2000). A species with S2 status is described as "very rare and imperiled," with as few as 6-20 documented cases in West Virginia. The northern leopard frog is listed as an S2 species. Drift fence arrays captured two individuals in forest fragments and two in shrub/pole habitat (Table 30). In addition, a few individuals were heard singing in a forest fragment (Table 29). S3 species documented in our study included the northern red salamander, little brown skink (discussed earlier), eastern wormsneak, timber rattlesnake, eastern hog-nosed snake, and northern rough greensnake. One of the seven timber rattlesnakes sighted was in an intact site, the other six were in or on the border of shrub/pole habitat; all were incidental sightings. One northern rough greensnake was found in shrub/pole habitat and the other in an intact forest, both as incidental sightings. Two eastern hog-nosed snakes were captured in shrub/pole habitat in funnel traps of the drift fence array. Another was captured in grassland habitat, also in a funnel trap, and there was one incidental sighting in grassland habitat. Three northern red salamanders were found at 2 intact forest sites, while a fourth was found in a forest fragment; this species was captured in both drift fence arrays and stream surveys.

Data from the 2001 stream surveys were not analyzed statistically because sample sites were not paired by stream order and structure. Therefore, these data are preliminary and will be used to more effectively design the surveys for 2002. Generally, a range of habitat conditions was sampled in the segments (Table 28).

A total of 678 stream herpetofauna of 15 species were captured in stream surveys. Total captures were higher in intact forest streams (IFS) ($n = 389$) than in fragmented forest streams

(FFS) (n = 289; Tables 34 and 36), although 2 extra stream segments were sampled in FFS. More species were captured in the FFS (n = 13) than in the IFS (n = 10). Salamanders comprised 97% of total captures, so toads, frogs, and snakes were excluded from abundance calculations per stream segment. Second order FFS had the highest (68.5 ± 7.5) and lowest (1.8 ± 0.97) means of stream salamanders per stream segment (Table 35). Mean abundance of herpetofauna and habitat characteristics per segment of stream sampled are summarized in Tables 35 and 36.

In summary, 6 additional species of herpetofauna were captured in 2001. Three of these (the northern rough greensnake, northern leopard frog, and northern red salamander) are listed as special status by the West Virginia Natural Heritage Program (2000) which brings the total to seven for the 2 years of the study. Overall species richness and abundance based on the array data for 2000 and 2001 did not differ among treatments. Although salamander abundance did not differ statistically among the treatments, it was generally higher within the 2 forested treatments. The only salamander species captured outside of a forested treatment in 2000 was a spotted salamander; it was found in a grassland site. This year, another spotted salamander was found in shrub/pole habitat and a four-toed salamander was found in a grassland.

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Table 1. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Dickcissels and Grasshopper Sparrows at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	Dickcissel					Grasshopper Sparrow				
	Absent		Present			Absent		Present		
	Mean	SE	Mean	SE	χ^2	Mean	SE	Mean	SE	χ^2
Aspect Code	0.9	0.1	1.3	0.2		0.7	0.2	1.0	0.1	
Slope (%)	13.1	1.5	21.8	6.6		8.5	2.1	16.5	1.9	
Distance to Minor Edge (m)	101.4	11.3	28.5	5.0		68.1	10.4	105.4	14.2	
Distance to Habitat Edge (m)	188.2	25.6	585.1	149.0	6.571	87.0	14.5	290.1	40.3	0.010+
Grass/Forb Height (dm)	6.9	0.3	5.9	1.1		6.0	0.6	7.2	0.3	
Litter Depth (cm)	2.0	0.1	1.9	0.4		1.5	0.2	2.2	0.2	
Robel Pole Index	3.5	0.2	3.8	0.5	4.043	4.2	0.3	3.2	0.2	0.044+
Elevation (m)	386.1	6.5	441.6	19.5		381.6	14.6	396.1	6.7	
<u>Tree Density (no./ha):</u>										
>0-2.5 cm	4050.7	885.6	175.8	137.5		8173.2	2143.6	1599.1	441.9	
>2.5-8 cm	509.5	149.5	46.9	25.7		1135.4	398.2	156.3	33.8	
>8-23 cm	60.7	13.2	0.1	0.1		143.2	29.9	14.2	5.3	19.810 <0.001-
<u>Ground Cover (%):</u>										
Water	0.1	0.1	0.3	0.3		0.1	0.1	0.2	0.1	
Litter	7.8	1.3	2.8	1.2		7.5	2.4	7.1	1.3	
Bareground/rock	4.4	0.7	13.8	4.1	9.611	2.6	1.2	6.6	1.0	0.002+
Woody Debris	0.2	0.1	0.0	0.0		0.3	0.2	0.1	0.0	
Moss	1.3	0.4	1.9	1.4		2.4	1.2	0.9	0.3	
Green	84.5	2.0	80.6	3.5		82.3	4.6	84.9	1.8	
Grass	45.6	2.9	34.8	6.1		43.6	6.1	44.9	2.9	
Forb	22.7	1.9	24.8	5.9		19.6	3.0	24.4	2.3	
Shrub	17.6	2.2	20.9	8.0		22.8	3.4	15.7	2.6	
Hosmer-Lemeshow										
Goodness-of-Fit Test					3.368	0.909		0.796		0.851

Table 2. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Eastern Meadowlarks and Red-winged Blackbirds at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The ‘-’ indicate a negative relationship between presence and the habitat variables. Only significant results are reported.

Variable	Eastern Meadowlark					Red-winged Blackbird					
	Absent		Present			χ^2	P	Absent		Present	
	Mean	SE	Mean	SE	Mean			SE	Mean	SE	
Aspect Code	0.9	0.1	1.1	0.1				0.8	0.1	1.1	0.1
Slope (%)	13.0	1.8	16.4	2.6				10.9	1.8	19.0	2.4
Distance to Minor Edge (m)	88.4	11.2	105.6	23.0				98.0	14.3	87.2	15.1
Distance to Habitat Edge (m)	161.4	30.0	373.2	61.9				176.8	28.6	308.3	61.1
Grass/Forb Height (dm)	6.5	0.3	7.6	0.4				6.4	0.4	7.4	0.3
Litter Depth (cm)	1.9	0.2	2.2	0.2				1.6	0.1	2.6	0.2
Robel Pole Index	3.8	0.2	2.9	0.3				3.8	0.2	3.0	0.2
Elevation (m)	392.3	8.4	390.4	9.4				403.8	8.1	373.0	9.9
<u>Tree Density (no./ha):</u>											
>0-2.5cm	5021.8	1119.1	614.6	172.9				3883.6	1097.7	3279.2	1163.2
>2.5-8cm	615.6	191.8	121.1	44.0	7.480	0.006-		465.4	105.3	455.2	308.0
>8-23cm	75.6	16.5	7.6	5.3				72.7	18.3	25.7	9.7
<u>Ground Cover(%):</u>											
Water	0.1	0.1	0.3	0.2				0.1	0.1	0.2	0.1
Litter	6.6	1.3	8.7	2.3				6.1	1.5	9.0	1.8
Bareground/rock	4.5	1.0	7.3	1.6				4.4	1.0	6.9	1.5
Woody Debris	0.2	0.1	0.1	0.1				0.2	0.1	0.2	0.1
Moss	1.7	0.6	0.7	0.4				1.3	0.6	1.5	0.6
Green	84.6	2.3	82.9	3.2				86.7	2.2	80.0	3.2
Grass	42.4	3.4	49.0	4.4				40.7	3.6	50.4	3.8
Forb	22.2	2.1	24.4	3.7				23.0	2.3	22.7	3.1
Shrub	21.7	2.6	9.5	3.2	4.813	0.028-		23.6	2.9	9.0	2.4
Hosmer-Lemeshow											
Goodness-of-Fit Test					10.231	0.249					

Table 3. Means, standard errors (SE) for the presence/absence of Horned Larks and Willow Flycatchers at point counts in grassland and shrub/pole habitats in southwestern West Virginia. No variables were chosen by stepwise logistic regression as predictors for either of these species.

Variable	Horned Lark				Willow Flycatcher			
	Absent		Present		Absent		Present	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Aspect Code	0.9	0.1	1.0	0.2	0.9	0.1	1.2	0.2
Slope (%)	11.8	1.5	22.0	4.0	14.1	1.7	13.9	2.0
Distance to Minor Edge (m)	90.2	11.3	106.5	26.2	88.1	10.4	142.4	45.1
Distance to Habitat Edge (m)	167.9	24.4	433.3	90.1	219.7	32.5	305.3	76.1
Grass/Forb Height (dm)	6.6	0.3	7.6	0.4	6.7	0.3	8.1	0.3
Litter Depth (cm)	1.8	0.1	2.8	0.3	1.9	0.1	2.4	0.3
Robel Pole Index	3.8	0.2	2.6	0.2	3.6	0.2	2.6	0.3
Elevation (m)	392.9	7.8	387.8	10.3	393.1	7.0	379.5	13.4
<u>Tree Density (no./ha):</u>								
>0-2.5cm	4373.4	1007.6	1088.2	435.0	3903.1	893.1	1449.2	242.1
>2.5-8cm	562.5	170.9	104.8	33.5	494.1	150.0	179.7	63.5
>8-23cm	69.8	14.9	0.0	0.0	60.7	13.2	0.0	0.0
<u>Ground Cover (%):</u>								
Water	0.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0
Litter	6.1	1.3	11.3	2.4	7.1	1.2	8.3	3.6
Bareground/rock	4.5	0.9	8.3	1.7	5.4	0.9	5.2	2.8
Woody Debris	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.2
Moss	1.3	0.5	1.7	0.8	1.4	0.5	1.1	0.9
Green	85.7	2.2	78.6	3.2	84.0	2.0	85.3	6.4
Grass	43.6	3.3	47.5	4.4	43.2	3.0	55.2	3.6
Forb	22.8	2.1	23.3	3.6	23.1	2.0	21.3	4.5
Shrub	20.8	2.5	7.8	3.2	19.0	2.3	8.9	3.0

Table 4. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of White-eyed Vireos and Yellow-breasted Chats at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The '-' and '+' indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	White-eyed Vireo					Yellow-breasted Chat						
	Absent		Present			P	Absent		Present			
	Mean	SE	Mean	SE	χ^2		Mean	SE	Mean	SE		
Aspect Code	1.0	0.1	0.8	0.2			1.0	0.1	0.9	0.1		
Slope (%)	14.4	1.7	12.9	3.1			17.7	2.3	10.1	1.7		
Distance to Minor Edge (m)	99.3	12.8	75.7	15.5			104.8	17.0	81.9	11.6		
Distance to Habitat Edge (m)	270.4	37.4	86.0	12.2			338.4	50.1	103.6	13.1		
Grass/Forb Height (dm)	6.8	0.3	6.8	0.6			7.2	0.3	6.4	0.4		
Litter Depth (cm)	2.0	0.1	2.1	0.3			2.2	0.2	1.8	0.2		
Robel Pole Index	3.3	0.2	4.2	0.4			3.1	0.2	4.0	0.3		
Elevation (m)	396.2	7.1	376.6	14.5			403.0	8.5	378.9	9.6		
<u>Tree Density (no./ha):</u>												
>0-2.5cm	2060.9	646.4	8850.7	2373.0	8.739	0.003+	566.4	171.9	6979.7	1488.7		
>2.5-8cm	434.3	171.5	550.3	136.6			152.3	40.9	795.6	268.4		
>8-23cm	45.2	14.1	84.7	21.6			29.6	15.5	81.3	17.8		
>23-38 cm	1.6	0.9	5.2	2.6			1.1	1.1	3.9	1.5		
Snags	5.4	2.7	7.3	2.9			0.9	0.9	11.5	4.4		
<u>Ground Cover (%):</u>												
Water	0.1	0.1	0.3	0.2			0.2	0.1	0.1	0.1		
Litter	7.1	1.4	7.8	2.1			6.6	1.7	8.0	1.6		
Bareground/rock	6.3	1.0	2.5	0.7			7.4	1.3	3.2	0.9		
Woody Debris	0.1	0.1	0.2	0.1			0.1	0.1	0.2	0.1		
Moss	1.3	0.5	1.7	0.7			1.6	0.7	1.2	0.4		
Green	83.1	2.3	87.4	2.3			84.1	2.5	84.1	2.8		
Grass	46.4	3.1	38.3	5.4			47.5	3.8	41.2	3.8		
Forb	21.6	2.1	27.2	3.5			19.5	2.4	26.6	2.6		
Shrub	16.6	2.5	22.1	4.2			17.1	3.3	18.8	2.6		
Hosmer-Lemeshow												
Goodness-of-Fit Test						5.037	0.656					
						</						

Table 5. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Prairie Warblers and Blue-winged Warblers at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	Prairie Warbler					Blue-winged Warbler							
	Absent		Present			Absent		Present					
	Mean	SE	Mean	SE	χ^2	P	Mean	SE	Mean	SE	χ^2	P	
Aspect Code	1.1	0.1	0.8	0.1			1.0	0.1	0.8	0.2			
Slope (%)	15.9	2.3	12.0	1.8	4.872	0.027-	14.7	1.7	12.0	2.9			
Distance to Minor Edge (m)	98.4	16.1	88.8	13.3			94.8	12.0	90.5	22.1			
Distance to Habitat Edge (m)	351.7	48.8	88.4	11.2	6.040	0.014-	267.0	37.5	97.4	16.5			
Grass/Forb Height (dm)	6.6	0.4	7.0	0.4			6.9	0.3	6.7	0.6			
Litter Depth (cm)	1.9	0.2	2.1	0.2	8.658	0.003+	2.0	0.1	2.0	0.3			
Robel Pole Index	3.2	0.2	3.9	0.3			3.4	0.2	3.9	0.4			
Elevation (m)	405.2	8.2	376.4	9.6			399.0	6.8	366.8	15.3			
<u>Tree Density (no./ha):</u>													
>0-2.5cm	2542.2	959.5	4843.8	1299.9			2583.2	756.8	7138.9	2245.4			
>2.5-8cm	351.6	232.1	580.2	126.8			180.1	32.8	1383.7	520.3	8.766	0.003+	
>8-23cm	38.8	19.5	71.3	13.3			44.2	14.0	87.9	21.8			
>23-38 cm	1.7	1.2	3.2	1.4	8.520	0.004+	1.4	0.8	5.9	2.8			
Snags	4.6	3.0	7.3	3.2			5.9	2.7	5.6	2.5			
<u>Ground Cover (%):</u>													
Water	0.2	0.1	0.1	0.1			0.1	0.1	0.2	0.2			
Litter	8.3	1.8	6.1	1.5			7.0	1.4	8.2	2.2			
Bareground/rock	8.2	1.4	2.3	0.6			6.1	1.0	3.0	0.8			
Woody Debris	0.1	0.1	0.2	0.1			0.1	0.1	0.2	0.1			
Moss	1.8	0.8	0.9	0.3			1.3	0.5	1.7	0.7			
Green	79.0	3.0	89.6	1.9	6.378	0.012+	84.9	2.0	81.6	4.4			
Grass	41.2	3.3	48.0	4.3			45.4	3.2	41.6	4.9			
Forb	22.1	2.5	23.7	2.7			22.5	2.1	24.2	3.9			
Shrub	17.3	3.0	18.6	3.1			17.1	2.5	20.8	4.1			
Hosmer-Lemeshow													
Goodness-of-Fit Test					8.395	0.396	7.755						0.170

Table 6. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Common Yellowthroats and Yellow Warblers at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	Common Yellowthroat					Yellow Warbler				
	Absent		Present		P	Absent		Present		χ^2
	Mean	SE	Mean	SE		Mean	SE			
Aspect Code	0.9	0.1	1.0	0.1		0.9	0.1	1.1	0.2	
Slope (%)	14.0	2.2	14.1	2.0		12.8	1.8	18.1	2.5	
Distance to Minor Edge (m)	107.0	16.3	79.5	12.6		91.9	11.9	100.0	22.5	
Distance to Habitat Edge (m)	270.1	40.3	183.4	44.8		224.2	35.0	241.7	61.3	
Grass/Forb Height (dm)	6.7	0.4	7.0	0.4		6.5	0.3	7.9	0.4	
Litter Depth (cm)	1.9	0.2	2.1	0.2		1.8	0.1	2.6	0.3	
Robel Pole Index	3.1	0.2	3.9	0.2		3.7	0.2	2.9	0.3	
Elevation (m)	409.1	7.9	373.0	9.6		404.0	7.4	353.0	8.8	8.119
<u>Tree Density (no./ha):</u>										
>0-2.5cm	1303.9	525.6	6182.4	1475.6	13.797	<0.001+	3413.7	949.3	4416.7	1502.7
>2.5-8cm	186.7	48.2	758.4	269.3			365.5	86.0	776.0	507.7
>8-23cm	48.9	20.2	60.3	12.5			55.3	14.3	51.4	21.6
>23-38 cm	3.4	1.7	1.4	0.6	4.157	0.041-	3.2	1.2	0.0	0.0
Snags	4.1	3.0	7.7	3.1			5.4	2.5	7.2	4.5
<u>Ground Cover (%):</u>										
Water	0.2	0.1	0.1	0.1			0.1	0.1	0.2	0.2
Litter	8.0	1.9	6.5	1.3			6.0	1.2	11.3	2.7
Bareground/rock	6.8	1.3	3.8	1.0			5.8	1.0	4.0	1.3
Woody Debris	0.2	0.1	0.2	0.1			0.1	0.1	0.3	0.1
Moss	1.2	0.7	1.5	0.5			1.3	0.5	1.6	0.7
Green	83.6	2.6	84.6	2.8			85.7	1.9	79.0	4.8
Grass	45.1	3.8	43.8	3.9			41.6	3.2	54.0	4.7
Forb	21.0	2.7	24.9	2.5			25.2	2.2	15.4	2.6
Shrub	17.6	3.0	18.3	3.1			19.4	2.4	13.1	4.8
Hosmer-Lemeshow										
Goodness-of-Fit Test					3.636	0.726	3.605			
							0.891			

Table 7. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Indigo Buntings and Northern Cardinals at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The '-' and '+' indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	Indigo Bunting					Northern Cardinal								
	Absent		Present			P	Absent		Present		χ^2	P		
	Mean	SE	Mean	SE	Mean		SE	Mean	SE					
Aspect Code	1.2	0.2	0.9	0.1			1.0	0.1	0.8	0.3				
Slope (%)	20.4	4.0	12.9	1.6			15.0	1.6	8.9	3.3				
Distance to Minor Edge (m)	107.8	35.1	91.2	10.7			97.2	11.8	75.4	20.6				
Distance to Habitat Edge (m)	364.8	81.8	199.0	31.4			255.7	34.6	75.9	13.0				
Grass/Forb Height (dm)	6.8	0.8	6.8	0.3			7.1	0.3	5.6	0.9				
Litter Depth (cm)	2.0	0.3	2.0	0.1			2.1	0.1	1.7	0.3				
Robel Pole Index	3.6	0.4	3.5	0.2			3.3	0.2	4.7	0.5				
Elevation (m)	397.7	15.0	390.4	7.2			393.4	6.4	382.3	23.6				
<u>Tree Density (no./ha):</u>														
>0-2.5cm	1291.7	1181.8	4083.2	920.6			2932.7	699.0	7523.4	3418.8				
>2.5-8cm	119.8	77.6	524.5	158.2	4.372	0.037+	377.9	144.9	914.1	350.3	5.134	0.0235+		
>8-23cm	17.7	13.1	61.2	13.9			50.4	13.8	76.0	18.6				
>23-38 cm	0.0	0.0	2.9	1.1			2.4	1.1	2.6	1.2				
Snags	1.3	1.3	6.8	2.6			6.2	2.5	4.2	2.9				
<u>Ground Cover (%):</u>														
Water	0.2	0.2	0.1	0.1			0.2	0.1	0.0	0.0				
Litter	6.0	2.2	7.5	1.3			7.5	1.3	6.0	2.3				
Bareground/rock	11.0	3.2	4.3	0.7	5.055	0.025-	5.6	0.9	4.4	2.5				
Woody Debris	0.0	0.0	0.2	0.1			0.2	0.1	0.2	0.2				
Moss	1.5	1.0	1.4	0.5			1.6	0.5	0.2	0.2				
Green	81.3	3.5	84.6	2.1			84.0	2.0	84.8	4.9				
Grass	42.8	5.4	44.8	3.1			46.0	2.7	36.3	9.0				
Forb	19.9	4.3	23.4	2.0			22.3	2.0	26.1	4.7				
Shrub	18.5	6.1	17.8	2.3			16.7	2.3	24.7	5.9				
<u>Hosmer-Lemeshow</u>														
Goodness-of-Fit Test						9.006	0.252						5.801	0.328

Table 8. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of American Goldfinches and Song Sparrows at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The '+' indicates a positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	American Goldfinch				Song Sparrow			
	Absent		Present		Absent		Present	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Aspect Code	1.0	0.1	0.9	0.1	0.9	0.1	1.3	0.2
Slope (%)	14.0	2.1	14.1	2.1	13.4	1.6	17.6	4.7
Distance to Minor Edge (m)	102.4	13.6	79.5	16.3	98.4	11.7	66.1	20.3
Distance to Habitat Edge (m)	238.2	40.1	211.5	45.4	177.8	21.8	510.9	134.7
Grass/Forb Height (dm)	6.7	0.3	7.1	0.5	6.9	0.3	6.6	0.8
Litter Depth (cm)	1.9	0.2	2.2	0.2	2.0	0.2	2.0	0.2
Robel Pole Index	3.5	0.2	3.5	0.3	3.4	0.2	4.0	0.6
Elevation (m)	395.5	7.8	385.2	11.3	386.6	7.0	420.3	14.7
<u>Tree Density (no./ha):</u>								
>0-2.5cm	4289.7	1167.6	2586.2	902.2	3730.1	872.2	3156.3	2179.2
>2.5-8cm	519.5	206.1	365.3	112.1	495.7	156.5	255.7	87.4
>8-23cm	60.3	17.4	44.6	14.1	57.2	13.5	37.5	24.2
>23-38 cm	2.5	1.1	2.4	1.7	2.7	1.1	1.1	1.1
Snags	5.6	2.7	6.3	3.8	5.6	2.3	7.3	6.2
<u>Ground Cover (%):</u>								
Water	0.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0
Litter	7.0	1.5	7.7	1.9	7.2	1.3	7.6	2.3
Bareground/rock	5.5	1.1	5.2	1.4	5.1	0.9	7.0	2.8
Woody Debris	0.2	0.1	0.2	0.1	0.2	0.1	0.0	0.0
Moss	1.7	0.6	0.9	0.4	1.2	0.4	2.6	1.3
Green	83.4	2.4	85.2	3.1	84.3	2.1	82.9	3.9
Grass	41.4	3.3	49.5	4.6	44.9	3.0	41.6	5.5
Forb	24.8	2.4	19.7	2.7	22.4	2.0	25.7	5.1
Shrub	19.0	2.6	16.1	3.6	18.3	2.3	15.5	5.7
Hosmer-Lemeshow								
Goodness-of-Fit Test	--				12.390			
					0.135			

Table 9. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Chipping and Field Sparrows at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Only significant results are reported.

Variable	Chipping Sparrow					Field Sparrow						
	Absent		Present		P	Absent		Present		χ ²	P	
	Mean	SE	Mean	SE		Mean	SE	Mean	SE			
Aspect Code	0.9	0.1	0.9	0.3		1.0	0.1	0.9	0.1			
Slope (%)	14.7	1.6	9.2	3.6		17.5	2.8	11.6	1.6			
Distance to Minor Edge (m)	100.3	11.6	44.6	9.7		85.8	12.6	99.5	15.6			
Distance to Habitat Edge (m)	245.8	33.5	92.8	21.0		313.2	56.8	164.3	28.3			
Grass/Forb Height (dm)	6.8	0.3	7.2	0.8		6.6	0.4	7.0	0.3			
Litter Depth (cm)	2.0	0.1	1.8	0.2		1.9	0.2	2.1	0.2			
Robel Pole Index	3.4	0.2	4.1	0.3		3.2	0.2	3.7	0.2			
Elevation (m)	392.2	7.0	387.6	15.3		406.3	9.0	380.7	8.8			
<u>Tree Density (no./ha):</u>												
>0-2.5cm	2918.2	765.9	9163.2	3346.8		2414.1	1127.1	4525.7	1111.3			
>2.5-8cm	413.6	148.9	822.9	241.1		410.2	289.9	497.9	107.8	5.736	0.0166+	
>8-23cm	48.5	13.4	99.3	11.8	7.952	0.0048+	46.5	23.9	60.0	11.8		
>23-38 cm	1.8	0.9	6.9	3.2		3.5	1.9	1.7	0.8			
Snags	3.5	1.9	24.3	11.1		7.0	4.3	5.0	2.1			
<u>Ground Cover (%):</u>												
Water	0.2	0.1	0.0	0.0		0.2	0.1	0.1	0.1			
Litter	7.5	1.3	5.7	2.2		7.4	2.0	7.2	1.4			
Bareground/rock	5.4	0.9	5.1	3.2		8.5	1.6	3.1	0.7	3.960	0.0466-	
Woody Debris	0.1	0.1	0.3	0.2		0.2	0.1	0.1	0.1			
Moss	1.4	0.5	1.3	0.8		1.3	0.8	1.4	0.4			
Green	83.6	2.1	87.7	4.0		80.2	3.4	86.8	2.1			
Grass	44.3	2.8	46.1	10.8		43.0	4.1	45.5	3.6			
Forb	22.7	1.9	24.6	5.9		20.6	2.7	24.5	2.4			
Shrub	18.0	2.3	17.1	4.7		18.6	3.5	17.4	2.7			
<u>Hosmer-Lemeshow</u>												
Goodness-of-Fit Test						7.101	0.069	4.323 0.742				

Table 10. Means, standard errors (SE), and stepwise logistic regression results for the presence/absence of Eastern Towhees at point counts in grassland and shrub/pole habitats in southwestern West Virginia. The '-' and '+' indicate either a negative or positive relationship between presence and the habitat variables.

Variable	Eastern Towhee				
	Absent		Present		P
	Mean	SE	Mean	SE	
Aspect Code	1.1	0.1	0.7	0.2	
Slope (%)	16.4	1.9	9.5	2.2	
Distance to Minor Edge (m)	104.3	14.8	73.1	10.3	
Distance to Habitat Edge (m)	298.7	41.4	85.0	13.5	
Grass/Forb Height (dm)	7.3	0.3	5.9	0.6	
Litter Depth (cm)	2.1	0.2	1.8	0.3	
Robel Pole Index	3.1	0.2	4.3	0.4	
Elevation (m)	393.5	7.2	388.2	13.3	
<u>Tree Density (no./ha):</u>					
>0-2.5cm	1984.1	597.8	6912.3	1945.1	
>2.5-8cm	393.4	190.6	595.0	142.1	
>8-23cm	25.6	11.6	110.8	24.1	19.783
>23-38 cm	0.6	0.4	6.0	2.5	<0.001+
Snags	5.3	2.8	7.0	3.4	
<u>Ground Cover (%):</u>					
Water	0.2	0.1	0.0	0.0	
Litter	6.6	1.3	8.5	2.3	
Bareground/rock	6.6	1.1	2.9	1.2	
Woody Debris	0.2	0.1	0.1	0.1	
Moss	1.1	0.4	1.9	1.0	
Green	83.4	2.2	85.6	3.6	
Grass	47.1	3.0	39.3	5.5	
Forb	22.8	2.3	23.0	2.9	
Shrub	15.2	2.4	23.3	4.0	
Hosmer-Lemeshow					
Goodness-of-Fit Test				1.072	0.784

Table 11. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of American Redstarts and Carolina Chickadees in forested habitats in southwestern West Virginia. The '-' and '+' indicate either a negative or positive relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	American Redstart				Carolina Chickadee				χ^2	P
	Absent (n=45)		Present (n=40)		Absent (n=49)		Present (n=36)			
	Mean	SE	Mean	SE	Mean	SE	Mean	SE		
Aspect Code	0.8	0.1	1.3	0.1	1.0	0.1	1.1	0.1	12.391	<0.001+
Slope (%)	33.8	2.1	33.8	2.2	34.1	2.1	33.3	2.2		
Elevation	359.0	10.3	376.4	11.6	378.5	10.3	350.6	11.2		
Distance to minor edge (m)	48.1	9.3	59.9	10.6	54.1	8.5	53.1	11.8		
Distance to habitat edge (m)	630.9	122.6	1262.7	181.4	1052.9	148.9	724.0	160.6		
Canopy height (m)	22.4	0.7	22.5	0.8	22.9	0.6	21.9	0.8		
<u>Ground Cover (%):</u>										
Water	0.8	0.3	0.8	0.2	0.7	0.2	0.8	0.3		
Bareground/rock	8.8	0.8	6.2	0.7	7.7	0.7	7.4	0.8		
Leaf litter	53.2	1.6	48.2	2.1	49.8	1.5	52.3	2.3		
Woody debris	4.9	0.4	4.3	0.5	4.9	0.4	4.3	0.4		
Moss	2.1	0.3	1.9	0.4	2.2	0.3	1.8	0.4		
Green	30.0	1.5	38.4	2.2	34.6	1.6	33.1	2.5		
<u>Tree Density (no./ha):</u>										
≤2.5 cm	6628.5	732.7	4501.6	429.7	6150.5	696.5	4915.8	466.5		
>2.5-8 cm	841.7	53.4	583.6	70.5	688.8	57.6	763.0	73.9		
>8-23 cm	305.3	23.2	283.4	22.9	263.0	18.8	338.5	27.5	5.635	0.018+
>23-38 cm	90.7	4.9	89.7	5.1	92.1	5.1	87.7	4.6		
>38-53 cm	32.8	3.0	28.6	2.6	31.0	2.6	30.6	3.1		
>53-68 cm	9.3	1.5	8.3	1.3	9.8	1.4	7.5	1.4		
>68 cm	3.6	0.7	3.4	0.8	3.2	0.6	4.0	1.0		
Snags (>8 cm)	46.1	5.3	45.1	6.2	45.2	5.2	46.3	6.3		

Table 11 cont.

<u>Canopy Cover (%):</u>										
>0.5-3 m	53.2	2.1	47.9	2.7	50.3	2.2	51.3	2.7		
>3-6 m	63.2	2.3	55.9	2.4	58.1	2.1	61.9	2.8		
>6-12 m	63.9	1.8	65.0	1.6	62.2	1.6	67.5	1.9		
>12-18 m	56.8	2.3	64.1	2.3	60.3	2.5	60.1	2.2		
>18 m	44.3	3.1	50.3	3.2	49.5	2.9	43.8	3.4		
>24 m	17.8	2.4	16.7	2.2	15.8	1.9	19.2	2.8		
Structural Diversity Index	59.8	1.4	60.0	1.4	59.3	1.3	60.8	1.5		
Hosmer-Lemeshow										
Goodness-of-fit Test										
				9.127	0.332		7.076	0.529		

Table 12. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of Northern Parulas and Carolina Wrens in forested habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	Northern Parula					Carolina Wren				
	Absent (n=62)		Present (n=23)		P	Absent (n=57)		Present (n=28)		χ^2
	Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Aspect Code	1.1	0.1	1.0	0.1		1.0	0.1	1.2	0.1	
Slope (%)	33.6	1.8	34.3	2.8		33.1	2.0	35.0	2.4	
Elevation	373.8	8.7	347.5	15.8		378.7	10.0	340.2	9.2	5.966
Distance to minor edge (m)	55.9	9.2	47.6	7.6		58.2	10.1	44.4	4.8	0.015-
Distance to habitat edge (m)	1017.3	131.8	631.7	192.0		990.1	138.3	747.8	178.0	
Canopy height (m)	22.3	0.6	22.9	0.8		22.3	0.6	22.8	0.9	
<u>Ground Cover (%):</u>										
Water	0.6	0.2	1.3	0.3		0.5	0.1	1.3	0.4	
Bareground/rock	7.4	0.7	7.9	0.8	6.815 0.009+	7.5	0.7	7.6	0.9	
Leaf litter	50.5	1.6	51.7	2.1		53.4	1.5	45.6	2.4	5.889
Woody debris	4.6	0.3	4.7	0.7		4.6	0.4	4.6	0.5	0.015-
Moss	1.9	0.3	2.3	0.3		2.0	0.3	2.0	0.4	
Green	34.8	1.7	31.7	2.1		31.8	1.6	38.3	2.5	
<u>Tree Density (no./ha):</u>										
≤2.5 cm	5594.8	554.7	5716.0	747.5		6008.2	547.9	4852.7	783.0	
>2.5-8 cm	677.4	51.4	835.6	93.1		766.4	54.5	626.1	81.0	
>8-23 cm	297.8	18.5	287.5	34.6		278.8	17.5	327.9	34.0	
>23-38 cm	91.1	4.0	87.8	7.3		90.1	4.3	90.4	6.3	
>38-53 cm	31.9	2.4	28.0	3.5		30.3	2.4	31.9	3.6	
>53-68 cm	9.7	1.2	6.5	1.7		8.3	1.1	9.8	2.0	
>68 cm	3.5	0.7	3.5	1.0		3.5	0.7	3.6	0.9	
Snags (>8 cm)	47.7	5.1	40.1	5.5		42.3	4.2	52.3	8.5	

Table 12 cont.

<u>Canopy Cover (%):</u>										
>0.5-3 m	49.0	2.0	55.4	3.3		51.9	2.0	48.2	3.2	
>3-6 m	56.9	1.9	67.4	2.9	8.859	59.8	2.1	59.6	2.7	
>6-12 m	64.8	1.3	63.4	2.9	0.003+	63.7	1.5	65.9	2.1	
>12-18 m	61.5	2.0	56.8	3.2	4.491	59.7	1.9	61.4	3.3	
>18 m	48.0	2.6	44.6	4.3	0.034-	51.0	2.5	39.1	4.0	
>24 m	17.3	1.9	17.1	3.2		18.9	2.0	13.9	2.7	
Structural Diversity Index	59.5	1.1	61.0	2.0		61.0	1.2	57.6	1.6	
Hosmer-Lemeshow										
Goodness-of-fit Test					9.761	0.282		5.656	0.686	

Table 13. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of Downy Woodpeckers and Tufted Titmice in forested habitats in southwestern West Virginia. The '+' indicates a positive relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	Downy Woodpecker					Tufted Titmouse					χ^2	P
	Absent (n=60)		Present (n=25)		P	Absent (n=60)		Present (n=25)				
	Mean	SE	Mean	SE		Mean	SE	Mean	SE			
Aspect Code	1.0	0.1	1.5	0.2	4.907	0.027+	1.0	0.1	1.1	0.1		
Slope (%)	33.8	1.6	33.3	5.3			33.5	1.9	34.3	2.5		
Elevation	371.3	8.6	337.7	12.4			366.5	9.7	367.7	12.1		
Distance to minor edge (m)	56.6	7.9	33.8	5.7			58.2	9.6	42.7	5.1		
Distance to habitat edge (m)	1008.6	120.4	302.8	200.1			830.9	124.1	1116.1	227.1		
Canopy height (m)	22.5	0.5	22.4	1.6			21.9	0.6	23.9	0.9		
<u>Ground Cover (%):</u>												
Water	0.8	0.2	0.7	0.4			0.8	0.2	0.6	0.3		
Bareground/rock	7.6	0.5	7.5	1.9			7.8	0.6	7.0	1.0		
Leaf litter	50.1	1.4	56.0	3.8			53.4	1.3	44.6	2.8		
Woody debris	4.7	0.3	4.3	0.9			4.5	0.4	5.1	0.5		
Moss	2.1	0.3	1.5	0.5			2.2	0.3	1.6	0.3		
Green	34.6	1.5	29.9	3.0			31.0	1.4	41.0	2.9	8.392	0.004+
<u>Tree Density (no./ha):</u>												
≤2.5 cm	5777.9	510.7	4616.5	477.9			5764.6	547.7	5298.8	796.7		
>2.5-8 cm	700.6	50.1	852.3	96.8			729.2	49.8	698.8	100.2		
>8-23 cm	286.7	16.4	351.1	61.0			300.5	21.0	281.8	23.5		
>23-38 cm	89.6	3.9	94.3	7.3			87.6	4.3	96.5	6.0		
>38-53 cm	30.2	2.2	35.2	5.1			30.8	2.5	30.8	3.0		
>53-68 cm	8.4	1.1	11.9	3.0			8.1	1.2	10.5	1.8		
>68 cm	3.4	0.6	4.5	1.7			3.0	0.6	4.8	1.2		
Snags (>8 cm)	45.8	4.5	44.9	6.2			45.3	5.0	46.5	6.7		

Table 13 cont.

<u>Canopy Cover (%)</u> :										
>0.5-3 m	51.5	1.9	45.5	4.1	52.0	1.9	47.7	3.6		
>3-6 m	59.2	1.9	63.4	3.5	59.9	1.8	59.3	3.7		
>6-12 m	64.1	1.3	66.9	3.7	64.3	1.6	64.7	1.8		
>12-18 m	60.3	1.8	60.1	5.7	59.9	2.0	61.0	3.3		
>18 m	47.0	2.5	47.7	3.6	48.4	2.8	43.9	3.3		
>24 m	17.1	1.8	18.0	3.2	18.1	2.0	15.1	2.6		
Structural Diversity Index	59.8	1.1	60.3	1.9	60.5	1.2	58.3	1.5		
Hosmer-Lemeshow										
Goodness-of-fit Test					4.854	0.773	3.748	0.879		

Table 14. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of Downy Woodpeckers and White-breasted Nuthatches in forested habitats in southwestern West Virginia. The ‘-’ indicates either a negative relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	Red-bellied Woodpecker					White-breasted Nuthatch				
	Absent (n=74)		Present (n=11)		P	Absent (n=65)		Present (n=20)		χ^2
	Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Aspect Code	1.0	0.1	1.0	0.2		1.0	0.1	1.0	0.1	
Slope (%)	32.9	1.6	39.6	5.3		32.8	1.7	36.9	3.4	
Elevation	371.1	8.3	336.0	18.3		370.6	9.6	354.1	9.7	
Distance to minor edge (m)	49.1	6.1	84.3	35.1		51.9	8.1	59.4	13.9	
Distance to habitat edge (m)	950.3	120.6	663.0	253.9		985.7	131.1	681.9	191.0	
Canopy height (m)	22.7	0.5	21.2	1.3		22.7	0.6	21.6	1.0	
<u>Ground Cover (%):</u>										
Water	0.8	0.2	0.7	0.5		0.8	0.2	0.6	0.3	
Bareground/rock	7.5	0.6	7.8	1.3		7.6	0.6	7.4	1.2	
Leaf litter	51.6	1.3	45.6	5.3		51.3	1.6	49.3	2.4	
Woody debris	4.7	0.3	4.0	0.8		4.6	0.4	4.7	0.5	
Moss	2.1	0.3	1.4	0.5		2.2	0.3	1.5	0.4	
Green	33.0	1.4	40.2	4.8		33.3	1.6	36.1	3.0	
<u>Tree Density (no./ha):</u>										
≤2.5 cm	5648.2	459.1	5488.6	1672.4		5193.8	365.5	7037.5	1485.8	
>2.5-8 cm	735.6	48.4	616.5	135.2		739.4	52.8	657.8	90.4	
>8-23 cm	285.4	15.6	359.7	69.9		297.9	19.4	285.6	29.6	
>23-38 cm	89.4	3.4	96.0	15.0		89.6	3.9	92.2	8.2	
>38-53 cm	31.2	2.1	28.4	5.7		29.2	2.3	35.9	4.1	
>53-68 cm	8.4	1.0	11.4	3.5		8.3	1.1	10.6	2.5	
>68 cm	3.8	0.6	1.7	0.9		3.2	0.6	4.7	1.2	
Snags (>8 cm)	43.4	4.1	60.3	13.6		44.9	4.4	48.2	9.4	

Table 14 cont.

<u>Canopy Cover (%):</u>										
>0.5-3 m	50.3	1.9	53.2	4.1	50.8	2.0	50.3	3.5		
>3-6 m	59.8	1.8	59.5	4.2	60.4	1.9	57.5	3.5		
>6-12 m	64.0	1.3	67.3	3.6	65.3	1.4	61.8	2.7		
>12-18 m	59.6	1.8	64.2	4.4	61.8	1.9	55.1	3.2		
>18 m	47.7	2.3	42.8	8.2	47.7	2.4	45.2	5.4		
>24 m	18.6	1.7	8.4	3.6	17.8	1.9	15.4	3.2		
					5.596	0.018-				
Structural Diversity Index	60.0	1.0	59.1	3.4	60.8	1.1	57.0	2.1		
Hosmer-Lemeshow										
Goodness-of-fit Test					4.235	0.835				

Table 15. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of Ovenbirds and Black-throated Green Warblers in forested habitats in southwestern West Virginia. The ‘-’ and ‘+’ indicate either a negative or positive relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	Ovenbird				Black-throated Green Warbler			
	Absent (n=14)		Present (n=71)		Absent (n=70)		Present (n=15)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Aspect Code	1.0	0.2	1.0	0.1	1.0	0.1	1.3	0.1
Slope (%)	29.0	2.9	34.7	1.7	33.0	1.6	37.4	4.7
Elevation	360.8	16.8	368.2	8.7	358.9	7.7	406.8	23.5
Distance to minor edge (m)	34.6	6.7	57.4	8.2	57.9	8.3	33.8	6.5
Distance to habitat edge (m)	549.3	230.6	999.7	123.6	907.1	120.9	958.3	280.1
Canopy height (m)	22.0	1.4	22.6	0.5	22.8	0.5	21.0	1.1
<u>Ground Cover (%):</u>								
Water	0.4	0.3	0.8	0.2	0.9	0.2	0.3	0.3
Bareground/rock	4.5	0.8	8.2	0.6	8.1	0.6	5.3	0.8
Leaf litter	58.8	1.8	49.2	1.5	50.2	1.5	53.7	2.1
Woody debris	5.6	0.5	4.4	0.3	4.7	0.3	4.2	0.8
Moss	2.6	0.6	1.9	0.3	2.0	0.3	2.2	0.6
Green	28.1	2.1	35.1	1.6	33.9	1.6	34.1	2.6
<u>Tree Density (no./ha):</u>								
≤2.5 cm	5783.5	1069.4	5596.8	499.1	5671.9	524.7	5420.8	743.4
>2.5-8 cm	988.8	101.1	667.3	48.6	718.3	48.8	729.2	125.7
>8-23 cm	348.2	58.0	284.5	15.8	319.0	18.2	182.9	19.1
>23-38 cm	90.6	7.0	90.1	4.0	92.8	4.0	78.3	6.8
>38-53 cm	26.8	5.6	31.6	2.1	29.3	2.1	37.9	5.1
>53-68 cm	10.7	3.4	8.5	1.0	8.7	1.2	9.6	1.2
>68 cm	3.1	1.6	3.6	0.6	3.5	0.6	3.8	1.0
Snags (>8 cm)	48.6	12.9	45.1	4.1	50.4	4.6	24.2	4.1

Table 15 cont.

<u>Canopy Cover (%)</u> :											
>0.5-3 m	56.7	3.6	49.5	1.9		50.2	1.9	53.1	4.0		
>3-6 m	69.6	3.7	57.8	1.8	7.400	60.2	1.9	57.7	3.4		
>6-12 m	70.2	3.4	63.3	1.3		65.4	1.3	59.8	3.0		
>12-18 m	55.2	4.6	61.2	1.8		59.4	1.8	64.1	4.5		
>18 m	39.6	5.9	48.6	2.4		45.3	2.5	55.7	4.7		
>24 m	18.2	3.8	17.1	1.8		17.4	1.9	16.8	3.1		
Structural Diversity Index	61.9	3.1	59.5	1.0		59.6	1.1	61.4	2.0		
Hosmer-Lemeshow											
Goodness-of-fit Test					13.590	0.093		6.680	0.572		

Table 16. Means, standard errors (SE), and stepwise logistic regression results (Wald Chi-square statistics) for presence/absence of Pileated Woodpeckers and Yellow-throated Warblers in forested habitats in southwestern West Virginia. The '-' indicates a negative relationship between presence and the habitat variables. Logistic regression results are given for significant variables only.

Variable	Pileated Woodpecker					Yellow-throated Warblers				
	Absent (n=75)		Present (n=10)			Absent (n=74)		Present (n=11)		
	Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Aspect Code	1.0	0.1	1.3	0.2		1.1	0.1	0.5	0.2	χ^2 4.630 0.031-
Slope (%)	32.9	1.6	40.1	3.8		32.3	1.6	43.6	3.5	
Elevation	368.8	8.3	350.8	20.2		367.1	8.0	364.9	27.9	
Distance to minor edge (m)	55.0	7.8	43.2	7.9		56.6	7.9	33.9	6.9	
Distance to habitat edge (m)	975.1	119.3	433.1	235.4		947.3	118.5	684.9	307.0	
Canopy height (m)	22.6	0.5	21.6	1.3		22.5	0.5	22.4	1.4	
<u>Ground Cover (%):</u>										
Water	0.7	0.2	1.0	0.6		0.9	0.2	0.0	0.0	
Bareground/rock	7.7	0.5	6.5	2.2		7.4	0.5	8.9	1.8	
Leaf litter	51.0	1.4	49.5	3.2		51.1	1.4	49.1	3.7	
Woody debris	4.8	0.3	3.3	0.8		4.6	0.3	5.1	0.9	
Moss	2.1	0.2	1.9	0.9		1.9	0.3	2.8	0.7	
Green	33.5	1.5	37.5	4.8		34.0	1.5	33.9	3.8	
<u>Tree Density (no./ha):</u>										
≤2.5 cm	5909.2	497.3	3515.6	510.7		5196.4	451.1	8528.4	1480.3	
>2.5-8 cm	736.3	47.3	600.0	156.4		709.5	50.4	792.6	96.9	
>8-23 cm	291.1	17.4	324.4	48.7		288.7	14.4	337.5	82.5	
>23-38 cm	88.5	3.8	103.1	7.9		89.9	3.8	92.0	9.4	
>38-53 cm	32.0	2.2	21.9	3.3		31.4	2.2	26.7	5.3	
>53-68 cm	9.1	1.1	6.9	2.2		8.0	1.0	14.2	2.9	
>68 cm	3.4	0.6	4.4	1.6		3.5	0.6	3.4	1.3	
Snags (>8 cm)	46.3	4.5	41.3	6.5		44.0	4.2	56.3	12.4	

Table 16 cont.

<u>Canopy Cover (%)</u> :										
>0.5-3 m	49.4	1.8	60.9	3.8	49.9	1.9	56.1	3.9		
>3-6 m	59.0	1.8	65.6	3.6	59.9	1.8	58.4	5.1		
>6-12 m	64.2	1.4	66.0	2.6	65.3	1.2	58.8	4.8		
>12-18 m	60.5	1.8	58.6	4.3	62.8	1.7	43.2	3.5	9.061	0.003-
>18 m	48.2	2.4	39.0	6.2	49.0	2.3	34.2	6.3		
>24 m	18.7	1.7	6.4	2.5	17.3	1.8	17.2	4.0		
				5.499	0.019-					
Structural Diversity Index	60.0	1.1	59.3	1.5	60.8	1.0	53.6	2.6		
Hosmer-Lemeshow										
Goodness-of-fit Test					6.326	0.611		4.361	0.823	

Table 17. Means and standard errors (SE) of habitat variables in relation to presence/absence of Summer Tanagers in forested habitats in southwestern West Virginia. No variables were chosen by stepwise logistic regression for predicting Summer Tanager presence.

Variable	Summer Tanager			
	Absent (n=70)		Present (n=15)	
	Mean	SE	Mean	SE
Aspect Code	1.1	0.1	1.0	0.2
Slope (%)	33.5	1.8	35.2	2.4
Elevation	363.6	8.3	383.5	20.9
Distance to minor edge (m)	52.6	7.4	58.4	20.1
Distance to habitat edge (m)	906.5	122.0	961.4	266.1
Canopy height (m)	22.6	0.6	21.6	1.0
<u>Ground Cover (%):</u>				
Water	0.9	0.2	0.2	0.2
Bareground/rock	7.8	0.6	6.3	1.1
Leaf litter	50.4	1.5	52.6	3.1
Woody debris	4.5	0.3	5.1	0.6
Moss	1.9	0.2	2.5	0.8
Green	34.1	1.5	33.3	3.6
<u>Tree Density (no./ha):</u>				
≤2.5 cm	5240.2	428.8	7435.4	1541.8
>2.5-8 cm	722.8	49.4	708.3	119.8
>8-23 cm	287.1	16.5	332.1	51.2
>23-38 cm	90.9	4.1	87.1	6.7
>38-53 cm	30.6	2.0	31.7	6.4
>53-68 cm	8.4	1.1	10.8	2.7
>68 cm	3.3	0.6	4.6	1.6
Snags (>8 cm)	43.8	4.0	54.2	12.8
<u>Canopy Cover (%):</u>				
>0.5-3 m	50.3	1.9	52.4	3.6
>3-6 m	60.0	1.8	58.3	4.5
>6-12 m	64.8	1.4	62.9	2.9
>12-18 m	60.6	1.9	58.4	4.1
>18 m	47.3	2.5	46.2	5.2
>24 m	16.6	1.7	20.3	4.2
Structural Diversity Index	59.9	1.0	59.7	2.7

Table 18. Mist net effort and the distribution of Grasshopper Sparrows captured and banded on study sites.

Site	Males	Females	Juveniles	Total Captures	Net Hours	Captures/Net Hour
CL1	21	7	2	29	124.00	0.23
CV2	11	7	3	21	72.25	0.29
DN2	29	7	2	22	85.00	0.26
DR1	27	3	14	56	217.63	0.26
HA1	30	3	6	40	210.25	0.19
HN2	22	6	2	25	76.50	0.33
Overall	140	33	29	193	785.63	0.25

Table 19. Systematic nest search effort and mean and SE of clutch size for Grasshopper Sparrow nests in the 2001 breeding season by site.

Site	Search effort (hrs)	No. Nests Found	Nests/hr	Clutch size	
				Mean	SE
CL1	72.57	4	0.06	3.25	0.75
CV2	44.33	3	0.07	4.00	0.00
DN2	48.91	10	0.20	3.80	0.33
DO1	0.33	2	6.06	3.50	0.50
DR1	26.00	5	0.19	3.40	0.60
HA1	108.50	7	0.65	3.88	0.23
HN2	69.24	4	0.06	3.67	0.67
HO1	2.00	2	0.50	4.50	0.50
Overall	372.14	37	0.10	3.73	0.16

Table 20. Mean and standard error (SE) of nest variables and habitat variables surrounding successful (n=17) and unsuccessful (n=20) nests of Grasshopper Sparrows on MTRVF areas in 2001. One-way analysis of variance (ANOVA) was used to compare habitat variables between successful and unsuccessful nests ($\alpha=0.05$).

Variable	Successful		Unsuccessful		ANOVA	
	Mean	SE	Mean	SE	F	P
Slope Aspect (degrees)	161.70	22.20	167.70	21.40	0.04	0.41
Slope (%)	12.30	2.90	8.30	3.00	0.90	0.35
Overhead Cover (%)	73.70	6.40	75.00	4.80	0.03	0.87
Side Cover (%)						
North	82.40	4.20	82.50	4.80	0.00	0.98
South	91.20	4.30	93.80	3.10	0.25	0.62
East	80.90	5.50	77.50	4.80	0.22	0.64
West	92.60	4.70	87.70	5.80	0.43	0.52
Distance to Minor Edge (m)	24.60	7.60	34.10	8.80	1.45	0.23
Ground Cover (%)						
Green	73.20	3.70	79.10	3.80	1.22	0.28
Grass	40.40	2.90	38.50	3.60	0.16	0.69
Forb	27.90	2.80	28.90	2.50	0.06	0.80
Shrub	0	0	0.01	0.01	0.85	0.36
Litter	8.30	1.20	8.30	0.90	0.00	0.97
Wood	0	0	0	0	-	-
Bare ground	20.90	3.80	18.40	3.04	0.27	0.61
Moss	2.20	0.70	2.90	1.01	0.41	0.53
Water	0	0	0	0	-	-
Robel Pole Index (dm)						
Nest	3.13	0.24	4.01	0.03	6.56	0.01
1m	3.17	0.29	4.28	0.31	6.69	0.01
3m	3.65	0.34	4.12	0.31	1.12	0.29
5m	3.71	0.30	3.88	0.32	0.14	0.71
Grass Height (dm)						
1m	2.91	0.19	3.26	0.19	2.01	0.16
3m	3.22	0.24	7.69	4.60	0.83	0.37
5m	3.27	0.23	3.24	0.23	0.002	0.96
10m	3.50	0.20	3.90	0.24	1.33	0.25
Litter depth (cm)						
1m	0.21	0.04	0.20	0.03	0.03	0.86
3m	0.30	0.05	0.25	0.04	0.66	0.42
5m	0.23	0.04	0.27	0.04	0.46	0.50
10m	0.24	0.04	0.30	0.04	1.03	0.31
Nest substrate height (veg)	3.75	0.22	4.27	0.28	0.44	0.51
Nest substrate height (repro)	7.65	0.47	7.00	0.41	1.06	0.31
Nest Clump Area (cm ²)	1,216.53	142.70	1,387.98	146.71	0.69	0.41
Distance to foliage edge (cm)	19.20	3.50	20.10	2.20	0.05	0.83
Nest depth (cm)	5.80	0.31	5.90	0.22	0.15	0.70
Nest width (cm)	6.60	0.15	6.50	0.12	0.19	0.66
Nest rim width (cm)	1.97	0.10	1.98	0.07	0.01	0.94
Nest rim height (cm)	1.80	0.27	1.50	0.23	1.05	0.31

Table 21. Mean and standard error (SE) for habitat variables measured at nests (N=37) and fixed habitat plots (N=48) sampling points. One-way analysis of variance (ANOVA) was used to compare habitat variables between successful and unsuccessful nests ($\alpha=0.05$).

Variable	Nests		Habitat Plots		ANOVA	
	Mean	SE	Mean	SE	F	P
Slope Aspect	164.90	15.20	207.15	17.50	3.09	0.08
Slope (%)	10.10	2.10	10.90	2.10	0.07	0.79
Distance to Minor Edge (m)	29.73	5.89	40.67	6.98	0.63	0.43
Ground Cover (%)						
Green	76.40	0.70	87.44	2.60	574.53	<0.0001
Grass	39.40	2.30	57.55	2.60	26.25	<0.0001
Forb	28.50	1.90	27.40	2.20	0.15	0.70
Shrub	0.01	0.01	0.05	0.05	0.56	0.46
Litter	8.31	0.70	5.70	0.64	7.56	0.01
Wood	0	0	0	0	-	-
Bare ground	19.60	2.40	7.14	1.20	24.73	<0.0001
Moss	2.60	0.60	1.34	0.41	3.05	0.08
Water	0	0	0	0	-	-
Robel Pole Index (dm)						
nest	3.60	0.19	1.50	0.07	24.16	<0.0001
1m	3.77	0.22	2.16	0.08	56.14	<0.0001
3m	3.91	0.23	2.05	0.09	67.41	<0.0001
5m	3.80	0.22	2.11	0.10	56.93	<0.0001
Grass Height (dm)						
1m	3.11	0.13	5.91	2.28	1.73	0.28
3m	5.63	2.48	3.62	0.11	0.85	0.36
5m	3.25	0.16	3.80	0.11	7.79	0.01
10m	3.70	0.16	4.03	0.13	2.63	0.11
Litter depth (cm)						
1m	0.21	0.02	0.13	0.01	7.53	0.01
3m	0.27	0.03	0.17	0.03	4.68	0.03
5m	0.26	0.03	0.15	0.03	6.80	0.01
10m	0.27	0.03	0.15	0.02	15.96	<0.001

Table 22. Percentage of adult *Peromyscus* spp. individuals in reproductive condition among grassland, shrub/pole, fragmented forest, and intact forest treatments in 1999 and 2000 in southwestern West Virginia.

Comparison	Treatment									
	Grassland		Shrub/Pole		Fragmented Forest		Intact Forest		ANOVA Results	
	%	N ^a	%	N	%	N	%	N	F	df P
<u>Among Treatments</u>										
1999										
Males	65.5A ^b	14	- ^c	-	39.9B	15	25.4B	16	7.18	2 0.0026
Females	41.9A	15	-	-	13.4B	16	4B	16	9.11	2 0.0002
Total	48.3A	16	-	-	25B	16	12C	16	11.33	2 0.0002
2000										
Males	79.8A	19	85.3A	11	83.3A	16	82.5A	19	0.45	3 0.7179
Females	55.8A	19	68.3A	12	54.5A	19	22.6B	16	4.57	3 0.0068
Total	66.2A	20	74.7A	12	63.2A	19	52.5A	16	1.05	3 0.3802
<u>Between Years</u>										
ANOVA Results										
Males	0.88	1 0.3586	- ^c	-	19.19	1 0.0002	33.73	1 <0.0001	-	-
Females	1.51	1 0.2302	-	-	14.5	1 0.0008	0.39	1 0.5360	-	-
Total	3.32	1 0.0795	-	-	17.33	1 0.0003	15.42	1 0.0007	-	-

^a N= number of trapping sessions multiplied by the number of transects in a given treatment.

^b Means followed by different letters within a row are significantly different from one another (Waller-Duncan k-ratio t-test, $P \leq 0.05$).

^c The shrub/pole treatment was not sampled in 1999.

Table 23. Relative abundance (mammals/100 trap nights), and standard error (SE) of *Peromyscus* spp. age and sex groups in grassland, shrub/pole, fragmented forest, and intact forest treatments in southwestern West Virginia for 1999 and 2000.

	Treatment												ANOVA Results		
	Grassland			Shrub/Pole			Fragmented Forest			Intact Forest					
	Mean	SE	N ^a	Mean	SE	N	Mean	SE	N	Mean	SE	N	F	P	
1999															
Adult Males	4.0A ^b	2.8	16	- ^c	-	-	1.8B	1.4	16	1.4B	1.6	16	8.20	0.0012	
Adult Females	2.1A	1.4	16	-	-	-	1.9AB	1.2	16	1.0B	1.2	16	3.51	0.0404	
Juvenile Males	4.5A	3.3	16	-	-	-	3.9A	1.5	16	5.3A	4.0	16	1.03	0.3656	
Juvenile Females	2.2A	2.0	16	-	-	-	3.1A	2.1	16	3.6A	2.7	16	2.11	0.1356	
2000															
Adult Males	6.2A	4.9	20	5.9A	3.8	12	2.3B	1.9	20	1.1B	1.8	20	13.13	<0.0001	
Adult Females	5.7A	4.0	20	6.2A	4.2	12	1.8B	1.4	20	1.9B	2.1	20	14.54	<0.0001	
Juvenile Males	4.6A	4.0	20	3.9AB	2.1	12	1.3C	1.2	20	2.5BC	3.0	20	5.99	0.0013	
Juvenile Females	3.8A	3.7	20	2.9A	2.5	12	0.7B	1.1	20	1.2B	3.0	20	7.50	0.0003	

^a N=number of trapping sessions multiplied by the number of transects in a given treatment.

^b Means followed by different letters within a row are significantly different from one another (Waller-Duncan k-ratio t-test, $P \leq 0.05$).

^c The shrub/pole treatment was not sampled in 1999.

Table 24. Results of multiple linear regression of mammal species richness, total abundance, and *Peromyscus* spp. abundance on habitat and environmental variables for shrub/pole, fragmented forest, and intact forest treatments. Significant variables in the model are listed below the dependent variable.

Variable	Parameter Estimate	<i>F</i>	<i>P</i>	Partial R ²	Model R ²
<u>Richness</u>					
Low Temp.	-0.0912	8.61	0.0044	0.0995	0.0995
Precip.	-0.2039	9.43	0.0030	0.0982	0.1977
Bare ground (%)	1.0570	4.60	0.0351	0.0458	0.2435
<u>Total Abundance</u>					
Canopy Cover >0.5-3 m	-16.4071	21.03	<0.0001	0.2123	0.2123
Canopy Height	-0.5107	8.82	0.0040	0.0809	0.2932
Precipitation	-2.0173	9.88	0.0024	0.0813	0.3745
Bare ground (%)	16.6469	11.43	0.0011	0.0827	0.4572
Low Temp.	-0.6224	9.16	0.0034	0.0598	0.5170
<u><i>Peromyscus</i> spp. abundance</u>					
Canopy Cover >0.5-3 m	-17.0509	34.86	<0.0001	0.3088	0.3088
Canopy Height	-0.4884	12.35	0.0007	0.0955	0.4044
Bare ground (%)	12.2341	7.32	0.0084	0.0523	0.4567
Precip.	-1.3118	8.11	0.0057	0.0530	0.5098

Table 25. Results of multiple linear regression of mammal species richness, total abundance, and *Peromyscus* spp. abundance on habitat and environmental variables for grassland treatment. Significant variables in the model are shown below the dependent variable.

Variable	Parameter Estimate	<i>F</i>	<i>P</i>	Partial R ²	Model R ²
<u>Richness</u>					
Average grass height	0.2297	10.60	0.0026	0.2376	0.2376
<u>Total Abundance</u>					
Green groundcover	99.9693	5.19	0.0295	0.3699	0.3699
Precipitation	2.1868	5.79	0.0221	0.0673	0.4372
Bareground	-44.4321	4.08	0.0518	0.0637	0.5009
<u><i>Peromyscus</i> spp. abundance</u>					
Bare ground (%)	-73.4487	15.88	0.0004	0.4454	0.4454
Precipitation	2.1953	7.11	0.0119	0.0942	0.5396
Shrub	3.0591	5.77	0.0223	0.0703	0.6099

Table 26. Results of logistic regression of short-tailed shrew, woodland jumping mouse, and chipmunk abundance on habitat and environmental variables within the shrub/pole, fragmented forest, and intact forest treatments.

Variable	Parameter Estimate	χ^2	P
<u>Short-tailed shrew</u>			
Bareground	4.36	4.2922	0.0383
Model		1.2314	0.8729
<u>Woodland jumping mouse</u>			
Moon illumination	-2.81	5.2752	0.0216
Water	7.84	4.0787	0.0434
Canopy Cover >0.5-3 m	8.33	3.625	0.0569
Model		8.5362	0.3829
<u>Eastern Chipmunk</u>			
Water	-22.14	9.0245	0.0027
Bareground	8.92	5.8598	0.0155
Canopy cover >12 m	6.25	5.6034	0.0179
Tree density >8-38 cm	0.01	8.378	0.0038
Model		32.8363	<0.0001

Table 27. Average mammalian species richness (# species/array), relative abundance (mammals/100 trap nights), and standard errors (SE) in grassland,shrub/pole, fragmented forest, and intact forest treatments in southwestern West Virginia in 2000 and 2001.

	Treatment												ANOVA Results	
	Grassland			Shrub/Pole			Fragmented Forest			Intact Forest				
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	F	P
<u>Species Richness</u>	39	2.85A ^a	0.25	39	2.74A	0.21	39	2.82A	0.28	41	1.88B	0.24	5.58	0.0014
<u>Relative Abundance</u>														
Total	39	10.37A	1.19	39	9.39A	1.11	39	9.48A	1.64	41	4.82B	0.85	5.70	0.0012
<i>Peromyscus</i> spp.	39	4.52A	0.73	39	3.61AB	0.74	39	3.20AB	0.73	41	1.77B	0.48	3.31	0.0229
Woodland jumping mouse	39	0.03B	0.03	39	0.05B	0.04	39	0.53A	0.14	41	0.08B	0.08	7.53	0.0001
Southern bog lemming	39	1.45A	0.34	39	0.98A	0.25	39	0.20B	0.09	41	0.00B	0.00	9.51	<0.0001
Woodland vole	39	0.09B	0.05	39	0.36AB	0.12	39	0.44AB	0.13	41	0.57A	0.20	2.34	0.0778
Meadow vole	39	0.21A	0.08	39	0.17A	0.09	39	0.30A	0.11	41	0.05A	0.04	1.72	0.1674
<i>Microtus</i> spp. ^b	39	0.58A	0.17	39	0.62A	0.17	39	1.18A	0.32	41	0.85A	0.30	1.45	0.2317
Short-tailed shrew	39	0.45B	0.20	39	0.51B	0.15	39	2.66A	0.81	41	0.52B	0.16	10.58	<0.0001
Masked shrew	39	2.20AB	0.44	39	2.94A	0.71	39	1.14BC	0.37	41	0.97C	0.24	4.74	0.0038
Smoky shrew	39	0.27A	0.10	39	0.12A	0.06	39	0.14A	0.07	41	0.23A	0.10	0.79	0.5008
Pygmy shrew	39	0.06AB	0.04	39	0.03B	0.03	39	0.26A	0.09	41	0.17AB	0.07	2.51	0.0630
<i>Sorex</i> spp. ^c	39	3.28A	0.56	39	3.62A	0.76	39	1.69B	0.41	41	1.55B	0.32	4.73	0.0039

^a Means followed by different letters within a row are significantly different (Waller-Duncan k-ratio t-test, P<0.05).

^b Combines woodland voles, meadow voles, and unidentified *Microtus* spp.

^c Combines masked shrews, smoky shrews, pygmy shrews, and unidentified *Sorex* spp.

Table 28. Habitat characteristics at forest fragment streams (n=4) and intact forest streams (n=3) by stream order.

Site No.	Segment	Substrate Type ^a	Channel Type ^a	No. of Coarse Woody Debris Sampled	No. of Rocks Sampled
Forest Fragment Streams – Second Order					
5	1	SR, RG	RI	21	689
	2	SR, RG	RI	7	480
	3	SR, RG	RI	12	137
	4	SR, RG, BA	RI	6	1554
	5	SR, RG, BA	RI	19	821
44	1	SR, RG, WD	PO, RU	24	67
	2	SR, RG, WD	RU	74	71
	3	SR, RG, WD	RU	39	98
	4	SR, RG, BA, WD	RI, PO, RU	95	75
	5	SR, RG, BA, WD	RI, PO, RU	104	127
173	1	SR, RG, BA, WD	RI, PO	19	3012
	2	SR, RG, BA	RI	0	1495
Forest Fragment Streams – Third Order					
131	1	SR, RG, LR	RA	5	758
	2	SR, RG, LR	RA	5	457
	3	SR, RG, LR, BL	RA, PO	0	343
	4	SR, RG, BA, LR	RI	6	1266
	5	SR, RG, BA	RI, PO	25	1935
Intact Forest Streams – Intermittent					
112	1	SR, LR	RI, PO, CA	25	638
	2	SR, LR	DR	37	527
	5	SR, LR, BA	DR	28	1144
Intact Forest Streams – First Order					
21	1	SR	RI	67	392
	2	SR	RI	38	579
	3	SR, RG, WD	RI	18	345
	4	SR, WD	RI, PO	61	1473
	5	SR, WD	RI, PO	3	1219
165	1	SR, LR	RI, PO	13	157
	2	SR, WD	PO	46	140
	3	SR, WD	DR	70	34
	4	SR, BA, WD	DR, PO	16	223
	5	SR, BA, WD, LR	DR, PO	111	698
Intact Forest Streams – Second Order					
112	3	SR, R/G	RI, PO	9	342
	4	SR, R/G, BA	RI, PO	3	2928

^a Habitat characteristics assessed qualitatively using a protocol modified from USGS Patuxent Wildlife Research Center (Jung et al. 1999).

BA = bank (river edge, soil, lacks rocks)
 BL = boulder (> 1.5 m in diameter)
 LR = large rocks (0.5-1.5 m in diameter)
 SR = small rocks (0.1-0.5 m in diameter)
 RG = rubble / gravel (< 0.1 m in diameter)
 WD = woody debris

RU = run (smooth current)
 RA = rapid (fast current broken by obstructions)
 PO = pool (standing water)
 CA = cascade (water flowing over slanting rocks)
 RI = riffle (ripples and waves)
 DR = dry (no visible moisture or water)

Table 29. Species expected (Exp) to occur in grassland, shrub/pole, fragmented forest, and intact forest treatments in our study area in southwestern West Virginia based on Green and Pauley (1987) and personal communication with T. Pauley, compared to those actually observed (Obs) in drift fence surveys (a), stream searches (s), and from incidental sightings (i), March – October 2000 and 2001.

Species	Grassland		Shrub/ pole		Fragmented Forest		Intact Forest	
	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs
Terrestrial species								
Salamanders								
Cumberland Plateau Salamander (<i>Plethodon kentucki</i>)					x		x	a,s,i
Southern Ravine Salamander (<i>Plethodon richmondi</i>)					x		x	
Eastern Red-backed Salamander (<i>Plethodon cinereus</i>)		i			x	i	x	a,s,i
Northern Slimy Salamander (<i>Plethodon glutinosus</i>)					x	a	x	a
Wehrle's Salamander (<i>Plethodon wehrlei</i>)					x		x	
Lizards								
Broad-headed Skink (<i>Eumeces laticeps</i>)					x		x	
Common Five-lined Skink (<i>Eumeces fasciatus</i>)	x		x	a	x	a	x	a
Little Brown Skink (<i>Scincella lateralis</i>)		a			x		x	a
Coal Skink (<i>Eumeces anthracinus</i>)	x		x		x		x	
Northern Fence-lizard (<i>Sceloporus undulatus hyacinthinus</i>)	x	a,i		a,i		i		
Snakes								
Eastern Black Kingsnake (<i>Lampropeltis getulus niger</i>)	x		x		x		x	
Black Rat Snake (<i>Elaphe o. obsoleta</i>)	x	a,i	x	a,i	x	a	x	i
Eastern Smooth Earthsnake (<i>Virginia v. valeriae</i>)	x		x		x		x	
Eastern Gartersnake (<i>Thamnophis s. sirtalis</i>)	x	a	x	a	x	a,i	x	a,i
Eastern Hog-nosed Snake (<i>Heterodon platirhinos</i>)	x	a,i		a				
Eastern Milksnake (<i>Lampropeltis t. triangulum</i>)	x	a	x	a	x	a	x	a,i
Smooth Greensnake (<i>Opheodrys vernalis</i>)	x			i				i
Eastern Wormsnake (<i>Carphophis a. amoenus</i>)	x		x		x		x	a
Northern Black Racer (<i>Coluber c. constrictor</i>)	x	a,i	x	a		i		i
Northern Brownsnake (<i>Storeria d. dekayi</i>)	x		x		x		x	
Northern Copperhead (<i>Agkistrodon contortrix mokasen</i>)		a		a	x	a	x	a,i
Northern Red-bellied Snake (<i>Storeria o. occipitomaculata</i>)	x		x		x	a	x	a,i
Northern Ring-necked Snake (<i>Diadophis punctatus edwardsii</i>)					x	s	x	i
Northern Rough Greensnake (<i>Opheodrys a. aestivus</i>)	x		x	i	x		x	i
Timber Rattlesnake (<i>Crotalus horridus</i>) ^a				i	x		x	i
Turtles								
Eastern Box Turtle (<i>Terrapene c. carolina</i>)	x	i	x	i	x	a,i	x	a,i
Semiaquatic species								
Salamanders								
Jefferson Salamander (<i>Ambystoma jeffersonianum</i>)					x		x	
Marbled Salamander (<i>Ambystoma opacum</i>)					x		x	
Spotted Salamander (<i>Ambystoma maculatum</i>)		a,i		a	x	a	x	a
Green Salamander (<i>Aneides aeneus</i>)					x		x	
Four-toed Salamander (<i>Hemidactylium scutatum</i>)		a			x	a	x	
Red-spotted Newt (<i>Notophthalmus v. viridescens</i>)		a,i		a,i	x	a,s,i	x	a,s,i
Toads and Frogs								
Eastern American Toad (<i>Bufo a. americanus</i>)	x	a,i	x	a,i		a,i		a,i
Fowler's Toad (<i>B. fowleri</i>) ^b		a	x			s,i		

Table 29. Continued.

Species	Grassland		Shrub/ pole		Fragmented Forest		Intact Forest	
	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs
Toads and Frogs (cont'd)								
Eastern Spadefoot (<i>Scaphiopus holbrookii</i>)					x		x	
Cope's Gray Treefrog (<i>Hyla chrysoscelis</i>)				a,i	x	i	x	i
Northern Spring Peeper (<i>Pseudacris c. crucifer</i>)		i		a,i	x	i	x	i
Mountain Chorus Frog (<i>Pseudacris brachyphona</i>)				i	x		x	i
Wood Frog (<i>Rana sylvatica</i>)					x	a	x	a,i
Northern Leopard Frog (<i>Rana pipiens</i>)	x		x	a	x	a,i	x	
Pickerel frog (<i>Rana palustris</i>)	x	a	x	a,i	x	a,s,i	x	a,s,i
Aquatic species								
Salamanders								
Seal Salamander (<i>Desmognathus monticola</i>)					x	a,s,i	x	a,s,i
Northern Dusky Salamander (<i>D. fuscus</i>)					x	a,s,i	x	s,i
Eastern Hellbender (<i>Cryptobranchus a. alleganiensis</i>)					x		x	
Midland Mud Salamander (<i>Pseudotriton montanus diastictus</i>)					x		x	
Common Mudpuppy (<i>Necturus m. maculosus</i>)	x		x		x		x	
Northern Red Salamander (<i>Pseudotriton r. ruber</i>)	x		x		x	s	x	a,s
Southern Two-lined Salamander (<i>Eurycea cirrigera</i>)					x	a,s,i	x	s,i
Long-tailed Salamander (<i>Eurycea l. longicauda</i>)	x		x		x	s,i	x	
Northern Spring Salamander (<i>Gyrinophilus p. porphyriticus</i>)					x	s	x	s,i
Toads and Frogs								
American Bullfrog (<i>Rana catesbeiana</i>)	x	a,i	x	a,i	x	a,s	x	s
Northern Green Frog (<i>Rana clamitans melanota</i>)	x	a,i	x	a,i	x	a,s,i	x	a,i
Snakes								
Common Watersnake (<i>Nerodia s. sipedon</i>)	x	a	x	a	x	s,i	x	
Queen Snake (<i>Regina septemvittata</i>)					x		x	
Turtles								
Eastern Snapping Turtle (<i>Chelydra s. serpentina</i>)	x	i	x	i	x	i	x	
Eastern Spiny Softshell Turtle (<i>Apalone s. spinifera</i>) ^c	x		x		x		x	
Midland Painted Turtle (<i>Chrysemys picta marginata</i>)	x		x		x		x	
Stinkpot (<i>Sternotherus odoratus</i>)	x		x		x		x	

^a One incidental sighting of a timber rattlesnake was also found on the edge between shrub/pole and fragmented forest habitats.

^b One incidental sighting of a Fowler's toad was also found on the edge between shrub/pole and fragmented forest habitats.

^c One incidental sighting of an eastern spiny softshell turtle was also found on the edge between grassland and fragmented forest habitats.

Table 30. Number of individuals of herpetofauna species captured in drift fence arrays and percent of points at which a species was captured in grassland (n = 3), shrub/pole (n = 3), fragmented forest (n = 3), and intact forest treatments (n = 4)^a on reclaimed MTMVF areas in southwestern West Virginia, March - October, 2000 and 2001.

Species	Grassland		Shrub/pole		Fragmented Forest		Intact Forest	
	No. indivs	% of points	No. indivs	% of points	No. indivs	% of points	No. indivs	% of points
<u>Salamanders</u>								
Seal Salamander					1	33	1	25
Cumberland Plateau Salamander							12	75
Four-toed Salamander	1	33			1	33		
Southern Two-lined Salamander					2	33		
Northern Dusky Salamander					1	33		
Northern Red Salamander							2	50
Eastern Red-backed Salamander							5	25
Red-spotted Newt	9	100	13	100	26	100	22	100
Northern Slimy Salamander					5	33	2	25
Spotted Salamander	1	33	1	33	1	33	1	25
<u>Toads and frogs</u>								
American Bullfrog	2	33	4	100	2	66		
Eastern American Toad	9	66	35	100	3	66	20	75
Fowler's Toad	2	33						
Cope's Gray Treefrog			2	33				
Northern Green Frog	52	100	46	100	44	100	6	75
Northern Leopard Frog			2	33	2	33		
Northern Spring Peeper			1	33				
Pickerel Frog	43	100	25	66	48	100	19	50
Unidentified Frog	5	66	2	33			1	25
Unidentified Toad					1	33		
Wood Frog					2	66	5	75
<u>Lizards</u>								
Common Five-lined Skink			2	66	4	33	2	50
Little Brown Skink	1	33					1	25
Northern Fence-Lizard	2	66	2	33				
<u>Snakes</u>								
Black Ratsnake	5	66	6	100	1	33		
Eastern Gartersnake	6	66	6	66	10	100	8	25
Eastern Hog-nosed Snake	1	33	2	33				
Eastern Milksnake	4	33	3	66	4	66	1	25
Eastern Wormsnake							2	25
Northern Black Racer	9	100	27	100				
Northern Copperhead	1	33	8	100	4	66	5	25
Northern Red-bellied Snake					1	33	1	25
Common Watersnake	1	33	1	33				
<u>Turtles</u>								
Eastern Box Turtle					2	66	1	25

^a A 4th drift fence array was installed in one of the intact forest points and opened for trapping in September and October, 2001.

Table 31. Herpetofaunal species richness and relative abundance from drift fence arrays in grassland, shrub/pole, fragmented forest, and intact forest treatments on reclaimed MTMVF areas in southwestern West Virginia, March - October 2000 and 2001 (adjusted for trap effort per 100 array nights).

	Grassland		Shrub/pole		Fragmented Forest		Intact Forest	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Species richness	1.04	0.28	1.13	0.26	1.20	0.32	1.07	0.25
Abundance								
Total	4.46	1.20	5.41	0.96	5.29	0.83	3.41	0.43
Amphibians	3.33	1.17	3.59	0.93	4.41	0.77	2.80	0.43
Reptiles	0.99	0.23	1.77	0.29	0.85	0.19	0.58	0.16
Terrestrial Species	0.95	0.21	1.73	0.09	1.03	0.22	1.26	0.28
Aquatic Species	1.51	0.74	1.41	0.37	1.59	0.51	0.25	0.09
Semi-aquatic Species	1.86	0.83	2.22	0.73	2.64	0.43	1.87	0.36
Salamanders	0.33	0.12	0.44	0.13	1.20	0.25	1.09	0.20
Toads and frogs	3.00	1.15	3.15	0.92	3.20	0.67	1.31	0.28
Snakes	0.90	0.22	1.64	0.27	0.67	0.14	0.46	0.15
Red-spotted Newt	0.26	0.10	0.41	0.13	0.83	0.20	0.69	0.27
Eastern American Toad	0.26	0.12	0.98	0.49	0.10	0.06	0.52	0.13
Northern Green Frog	1.40	0.74	1.25	0.35	1.40	0.47	0.15	0.06
Pickerel Frog	1.22	0.67	0.67	0.27	1.52	0.30	0.48	0.20
Eastern Gartersnake	0.19	0.10	0.17	0.09	0.36	0.12	0.22	0.09
Northern Black Racer	0.32	0.11 AB	0.84	0.17 A	0.00	0.00 B	0.00	0.00 B

^a Within a row, means with the same letter are not different at $\alpha = 0.05$ (Waller Duncan K-ratio t Test).

Table 32. Number of individuals and species of herpetofaunal groups captured in drift fence arrays in grassland, shrub/pole, fragmented forest, and intact forest treatments on reclaimed MTMVF areas in southwestern West Virginia, March-October, 2000 and 2001.

Taxonomic Group	Grassland						Shrub/pole						Fragmented Forest						Intact Forest					
	Individuals			Species			Individuals			Species			Individuals			Species			Individuals			Species		
	n	%		n	%		n	%		n	%		n	%		n	%		n	%		n	%	
Salamanders	11	7.1		3	17.6		14	7.4		2	11.1		37	22.4		7	35.0		45	38.4		7	36.8	
Toads and frogs	113	73.4		5	29.4		118	62.4		7	38.9		102	61.8		6	30.0		51	43.6		4	21.1	
Lizards	3	2.0		2	11.8		4	2.1		2	11.1		4	2.4		1	5.0		3	2.6		2	10.5	
Snakes	27	17.5		7	41.2		53	28.1		7	38.9		20	12.1		5	25.0		17	14.5		5	26.3	
Turtles	0	0.0		0	0.0		0	0.0		0	0		2	1.2		1	5.0		1	0.9		1	5.3	

Table 33. Mean and standard error (SE) for habitat variables measured at grassland (n=3), shrub/pole (n=3), fragmented forest (n=3), and intact forest (n=3) sampling points ^a.

Variables	Treatment							
	Grassland		Shrub/Pole		Fragmented Forest		Intact Forest	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Slope (%)	20.67	8.97	4.42	4.42	28.42	7.53	22.58	9.38
Aspect Code	1.62	0.06	0.60	0.57	0.73	0.14	0.68	0.13
Grass/Forb Height (dm)	6.80	1.69	4.09	1.91	-- ^b	--	--	--
Litter Depth (cm)	2.60	1.04	1.06	0.33	--	--	--	--
Elevation (m)	413.67	37.95	412.00	39.53	335.00	20.95	444.67	66.23
Distance to Minor Edge (m)	94.00	48.19	61.00	8.79	54.92	19.44	118.75	91.04
Distance to Habitat Edge (m)	408.73	324.42	68.8	15.66	175.87	77.46	1744.97	562.73
Distance to Forest/Mine Edge (m)	535.12	267.58	271.11	187.46	175.87	77.46	1744.97	562.73
Robel Pole Index	3.07	0.71	4.98	0.40	--	--	--	--
Canopy Height (m)	--	--	3.40	0.75	22.9	1.59	22.4	1.85
<u>Ground Cover (%)</u>								
Water	0.00	0.00	0.33	0.22	0.42	0.30	0.08	0.08
Bareground	1.33	0.79	0.5	0.14	0.83	0.08	1.83	0.71
Litter	2.42	1.53	1.67	1.67	11.50	0.63	10.58	1.23
Woody Debris	0.00	0.00	0.00	0.00	0.75	0.14	0.58	0.17
Moss	0.00	0.00	0.75	0.63	0.17	0.08	1.17	0.58
Green	16.25	1.26	15.08	2.93	6.33	0.30	5.75	0.90
Forb Cover	5.75	2.75	6.17	0.60	--	--	--	--
Grass Cover	6.75	2.38	4.42	2.19	--	--	--	--
Shrub Cover	3.75	3.63	4.50	1.13	--	--	--	--
<u>Stem Densities (no./ha)</u>								
<2.5 cm	42.00	41.50	5156.25	2044.75	2854.17	1464.90	6843.75	1043.18
>2.5-6 cm	0.00	0.00	406.25	62.5	562.50	118.31	343.75	160.36
>8-23 cm	0.00	0.00	85.42	33.53	225.00	71.90	275.00	74.56
>23-38 cm	0.00	0.00	0.00	0.00	68.75	25.26	81.25	19.09
>38-53 cm	0.00	0.00	0.00	0.00	33.33	11.60	10.42	2.08
>53-68 cm	0.00	0.00	0.00	0.00	2.08	2.08	2.08	2.08
>68 cm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<u>Canopy Cover (%)</u>								
>0.5-3 m	--	--	5.58	1.34	9.92	2.05	10.75	2.22
>3-6 m	--	--	4.00	2.08	13.00	1.44	10.42	1.52
>6-12 m	--	--	1.58	1.46	12.67	2.35	13.33	0.36
>12-18 m	--	--	0.00	0.00	10.17	0.79	14.67	1.45
>18-24 m	--	--	0.00	0.00	6.33	3.17	10.17	2.34
>24 m	--	--	0.00	0.00	3.83	2.00	2.75	2.38
Structural Diversity Index	--	--	11.17	4.69	55.92	2.42	62.08	5.60

^a This table does not include habitat variables for the most recently added intact sampling point (herp data collection started September 2001 for this point).

^b Variables were not measured in this treatment.

Table 34. Number of individuals and species of herpetofauna groups captured in stream surveys in fragmented forest streams and intact forest streams on reclaimed MTMVF areas in southwestern West Virginia, May-October, 2001.

Taxonomic Group	Fragmented Forest Streams				Intact Forest Streams			
	Individuals		Species		Individuals		Species	
	n	%	n	%	n	%	n	%
Salamanders	270	93.4	7	53.8	386	99.2	8	80.0
Toads and frogs	16	5.5	4	30.8	3	0.8	2	20.0
Lizards	0	0.0	0	0.0	0	0.0	0	0.0
Snakes	3	1.1	2	15.4	0	0.0	0	0.0
Turtles	0	0.0	0	0.0	0	0.0	0	0.0

Table 35. Mean number of individuals and standard error (SE) of stream salamanders per segment of fragmented forest streams and intact forest streams on reclaimed MTMVF areas in southwestern West Virginia, May–October 2001.

Treatments							
Fragmented Forest Streams				Intact Forest Streams			
Site No.	No. Segments Sampled	Mean	SE	Site No.	No. Segments Sampled	Mean	SE
<u>Second Order</u>				<u>Intermittent</u>			
5	5	5.4	0.93	112	3	21.0	6.11
44	5	1.8	0.97	<u>First Order</u>			
173	2	68.5	7.50	21	5	16.0	2.74
<u>Third Order</u>				165	5	30.6	9.08
131	5	19.4	7.53	<u>Second Order</u>			
				112	2	45.0	25.00

Table 36. Number of individuals for species of herpetofauna captured during stream surveys in southwestern West Virginia, May-October, 2001.

Species	Fragmented Forest		Intact Forest		
	Second Order	Third Order	Intermittent	First Order	Second Order
Salamanders					
Cumberland Plateau Salamander			1		
Eastern Red-backed Salamander			8		
Seal Salamander	7	8	34	57	17
Northern Dusky Salamander	76	42		102	47
<i>Desmognathus</i> spp. (Seal or N. Dusky)	7	8	8	22	8
Southern Two-lined Salamander	57	15	8	21	7
Long-tailed Salamander	1	1			
Northern Spring Salamander	2		1	2	1
Red-Spotted Newt	6	2		1	4
Northern Red Salamander		1	1		
Unidentified Salamander	20	20	2	28	6
Total	176	97	63	233	90
Toads and Frogs					
Fowler's Toad	1				
American Bullfrog	1			1	
Northern Green Frog	5				
Pickerel Frog	3			1	
<i>Rana</i> spp.	3				
Unidentified Frog				1	
Total	13	0	0	3	0
Snakes					
Northern Ring-necked Snake	1				
Common Watersnake	1	1			
Total	2	1	0	0	0
Grand Total	191	98	63	236	90